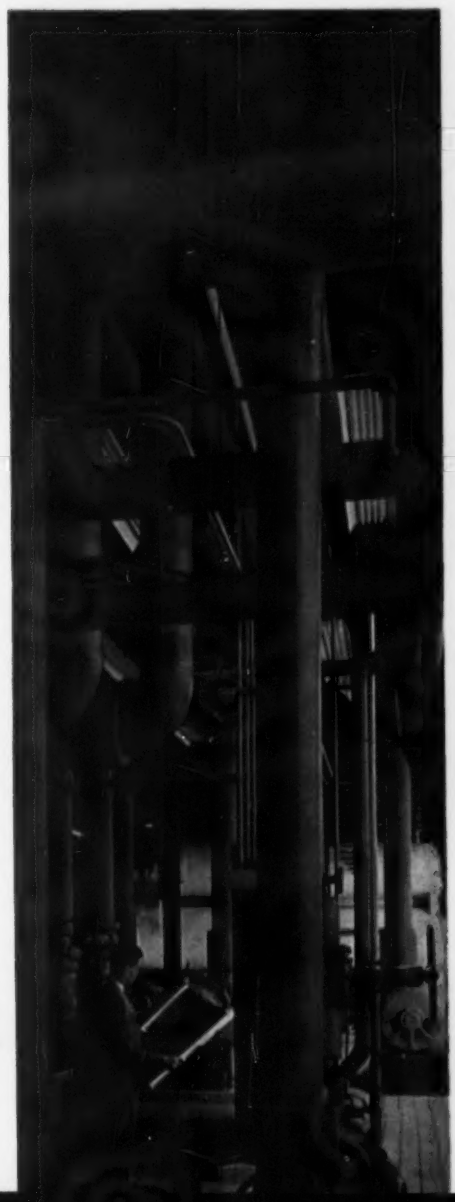
A McGRAW-HILL PUBLICATION JUNE 1960
ONE DOLLAR

# Power

*the magazine of energy systems engineering*



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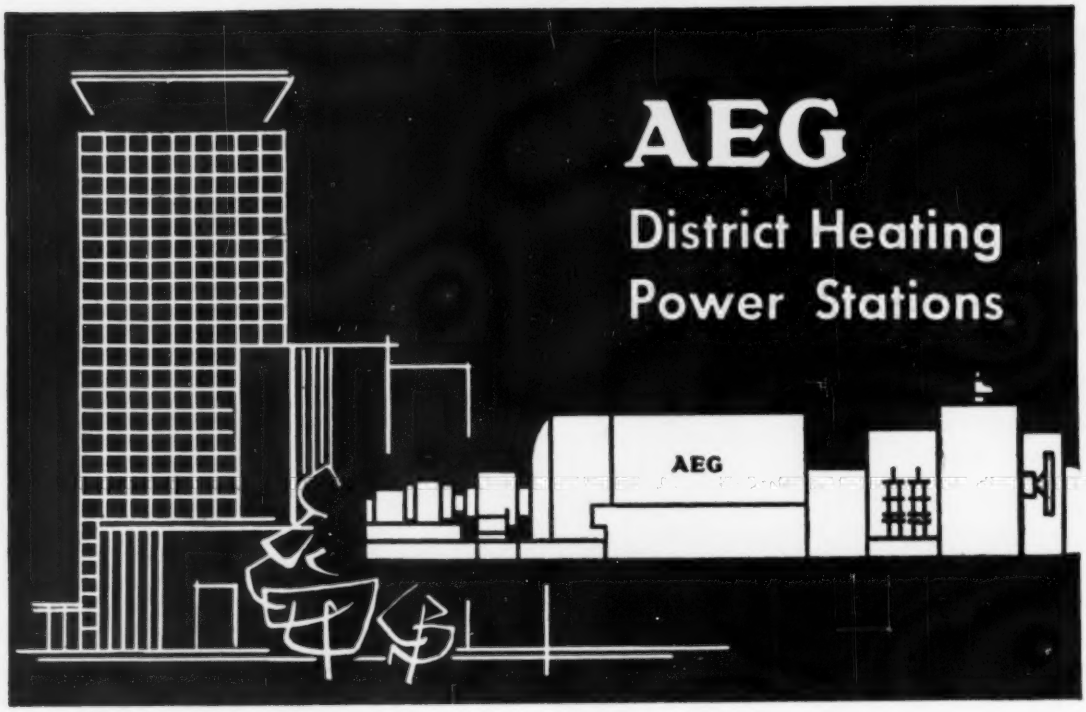


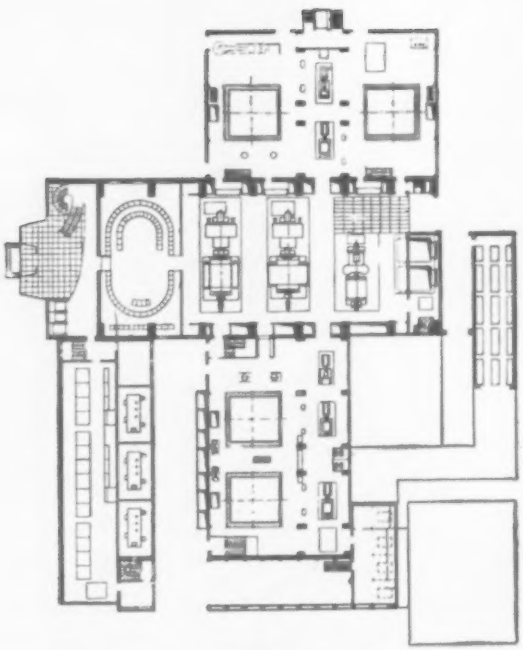

Plan of Müllerstrasse Power Station, Munich

Today, city planners make full use of the advantages of modern district heating power stations that supply steam for heat and power generation.

Centralized heat supply for higher thermal utilization, simplified fuel and ash handling, reduced atmospheric pollution.

Planning and electrical equipment by AEG.

AEG

8753 e

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For more facts circle 201 on Reader Service card, p 103

NOW...WITH GREEN SEAL

GOODYEAR

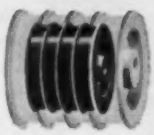
# HY-T WEDGE V-BELTS

## ...increase horsepower as much as 30%

over "super-rated" V-belts

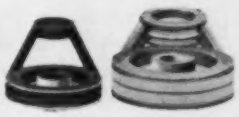
## ...yet reduce sheave widths up to 20%

with these narrower-faced belts



## ...with the same number of belts

because each belt does more!



Leave it to Goodyear—pioneer of the original "wedge" design. By stripping away excess bulk by dimensionally stabilizing via Goodyear's exclusive 3-T processed cord and by building in oil-resistant and static-conducting features (at no extra cost) they give you completely matched sets of super V-belts. With these HY-T WEDGE V-Belts you handle substantially greater horsepower—on more compact drives—over a longer, more trouble-free service life.

For the full story on HY-T WEDGE V-Belts or any other belt in the complete Goodyear line, contact the G.T.M.—Goodyear Technical Man—through your Goodyear Distributor. Or by writing Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

Lots of good things come from

GOODYEAR

HY-T, Green Seal—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

THE GREATEST NAME IN RUBBER



For more facts circle 204 on Reader Service card, p 103

## speaking of **Power**

**Baptism of fire,** in a purely editorial sense, comes to a POWER staffer while developing his first *special* report. True, experience gained editing submitted articles and writing features under his own byline helps pave the way. But it's not until he completes a *special* report that he gains a real appreciation of the many man-days (and nights) necessary to turn an idea into a finished product. Assistant Editor Ted Edwards has just completed that course, nine months after joining the staff. For results see *Piping*, starting on p 51.

Ted discovered in his early researching that there was no shortage of raw material—texts, handbooks, technical literature were in abundance. As is generally the case in writing a POWER *special* report, the big problem was one of skillfully condensing a tremendous volume of material into sixteen highly practical easy-to-read pages. One example of this condensation technique is the table of pipe fittings on p 62.

**Edwards' real start** on the report was made when he figuratively stepped back to survey the field, keeping in mind a well-defined audience. Ted visualized typical users of this report as energy-system engineers whose position demands managerial contact with the broad field of piping, or engineers who are called, on occasion, to design or consult on a specific piping proposal. Needs of such a group are of necessity quite apart from those of the day-to-day piping-system designer.

This audience was never forgotten as Ted researched, organized and designed his report. It was user-visualization that guided him in judicious selection of pertinent data.

Then just as the report was ready for wrapup, decision was made to use the colorful piping setup at Idlewild International Airport's power plant on our cover. And what could be more fitting than to follow the course we did—having Ted pose in the photo as the engineer-with-blueprint.

Lou Lowley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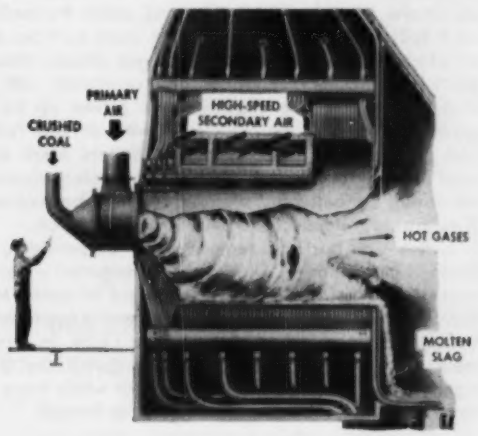
# Thos. H. Allen Electric Generating Station,

# Memphis, Tennessee . . . 6 Million lb of Steam per hr

| CONDITIONS: | |
|---|---|
| PRESSURE (TURBINE THROTTLE) | 2400 psi plus overpressure |
| CIRCULATION | Natural Circulation |
| TEMPERATURE | 1053F/1053F |
| FIRING | Cyclone Furnace |
| OTHER FEATURES | Gas Tempering |

**Natural circulation is self stabilizing over varied operation conditions at pressures of 2400 psi and higher—cuts boiler maintenance—no power loss to circulating pumps.**

November, 1959, saw the third 2 million lb natural circulation boiler on the line in the Thos. H. Allen Electric Generating Station of Memphis, Tennessee. Although normally operated with 2400 psi at the turbine throttle, these units are capable, by design, of peaking operation at overpressure conditions for maximum kilowatt output as evidenced by actual test results. These units again demonstrate the advantages of natural circulation at the higher operating pressures and temperatures necessary for maximum power generating efficiency. Burning some 300 tons of West Kentucky coal hourly in 21 B&W Cyclone furnaces, the station has a net generating capacity of 812,500 Kw.




Cross section view of a B&W Cyclone Furnace. Molten slag holds coal and ash permitting rotary air motion to "wash out" maximum BTUs, and reducing ash in boiler and convection passes. The Cyclone Furnace handles a wider range of coals, especially in the lower grades, and helps reduce fuel-costs and ash handling in power stations across the nation.

Use of natural circulation—which is self-stabilizing under conditions of sudden overload and fluctuations in firing—is possible in the high pressure, high temperature range through B&W's development of the Cyclone Steam Separator. It is this device that provides the steam free head of water for efficient functioning of the natural circulation system. With Cyclone Steam Separators, boilers functioning at the throttle pressures of 2400 psi and higher, provide more efficient operation plus operating and capital economies—factors underscored by carefully considered utility choice.

The City of Memphis' Thos. H. Allen installation is representative of advanced steam generating stations across the nation. Utilizing such B&W design advantages as natural circulation, the Cyclone Steam Separator, the Cyclone Furnace, and gas tempering—these stations are helping to meet the surging needs for electric power.

In planning system expansion, B&W can talk your language in terms of efficiency and future operating economies. You'll find B&W sales engineers ready to work with you at every stage of your planning. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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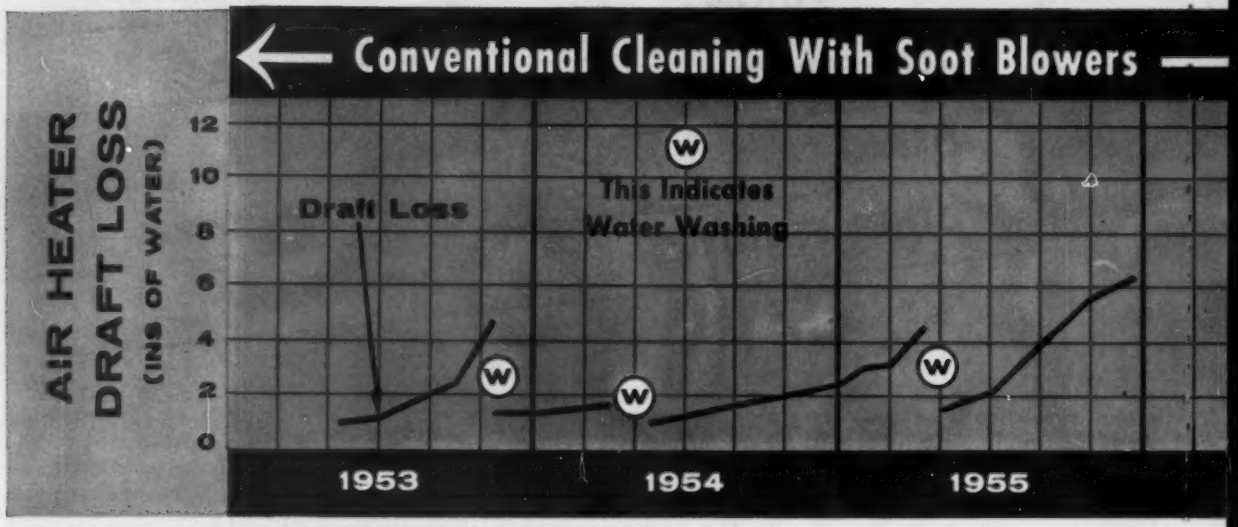
# DIAMOND

## *Keeps* TUBULAR AIR That Could Not




Here is an example of how Diamond Shot Cleaning solves certain cleaning problems previously impossible of solution.

The chart shows increase in draft loss across a tubular air heater resulting from ineffective soot blower cleaning. Mounting draft loss caused decrease in fan capacity and reduction in load. During the first four years of operation it was necessary to water wash this air heater six times (at "W"). Each washing required a three day outage of the boiler.

Diamond Shot Cleaning was installed in September 1957. Since then draft loss has been minimum and uniform. Water washing with consequent boiler outage has been eliminated entirely.

This first installation was so successful that a second air heater was equipped with shot cleaning in 1958.

Diamond Shot Cleaning uses falling shot to clean horizontal tube surfaces such as superheaters, reheaters and economizers, as well as tubular air heaters. The shot is cascaded over the horizontal tubes or through vertical air heater tubes by distributors and scours the surfaces as it falls. Deposits are removed in small particles most of which are carried away by the gas stream. Heavier particles fall into the hopper and recirculate with the shot until broken fine enough to be picked up by the gases. Cleaning is thorough even with difficult fouling such as is found in black liquor fired boilers. Areas which tend to foul rapidly can be kept completely clean by increasing the automatic shot cycle (it may be continuous if necessary) without disturbing boiler operation.

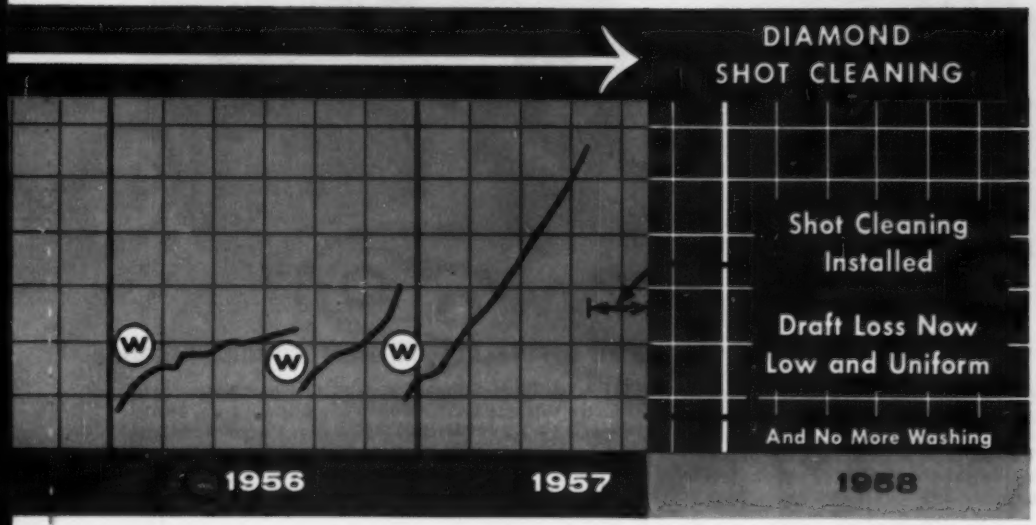
In line with our half century policy of providing the best in boiler cleaning, Diamond has conducted extensive research on shot cleaning over a period of years. More than 30 installations are now in successful operation in United States . . . some of them since 1954. To supplement this program, Diamond has acquired the U. S. rights to the Broman-Ekstrom system, of which there are more than 800 successful installations in Europe.

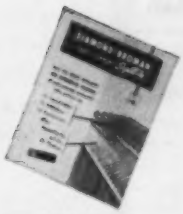
**DIAMOND POWER SPECIALTY CORP.**
**LANCASTER, OHIO**

# Shot Cleaning

## HEATERS CLEAN

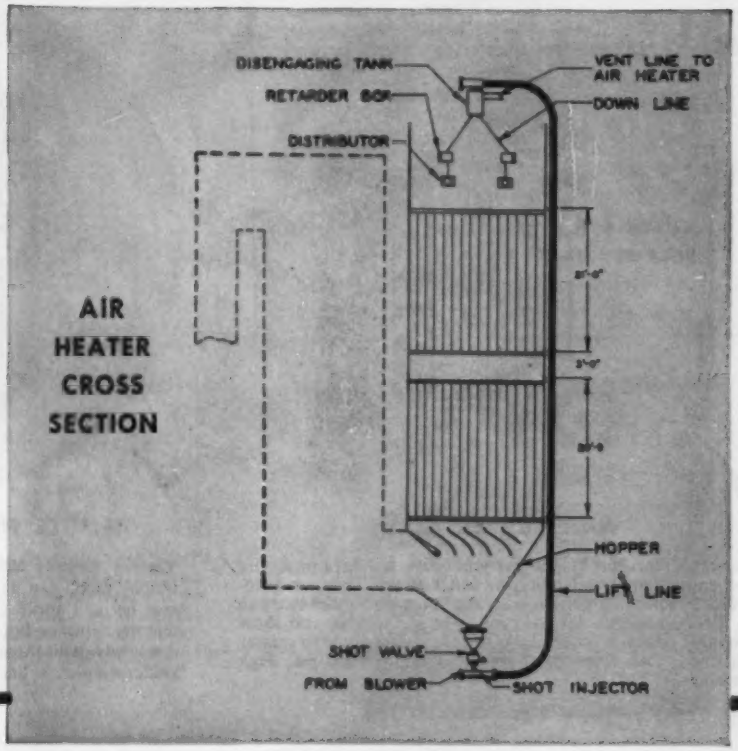
## be CLEANED BEFORE



**WRITE FOR BULLETIN 2145 ON DIAMOND SHOT CLEANING**

It has complete information, including data on shot lifting methods. For better boiler cleaning at lower cost, the answer always is Diamond.



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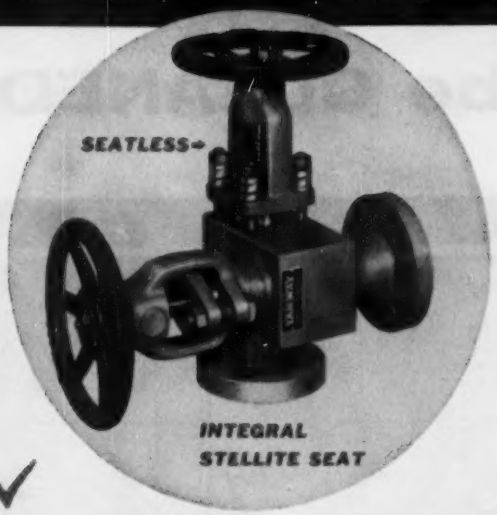
# IT'S BOILER

Check these 7 ways Yarway

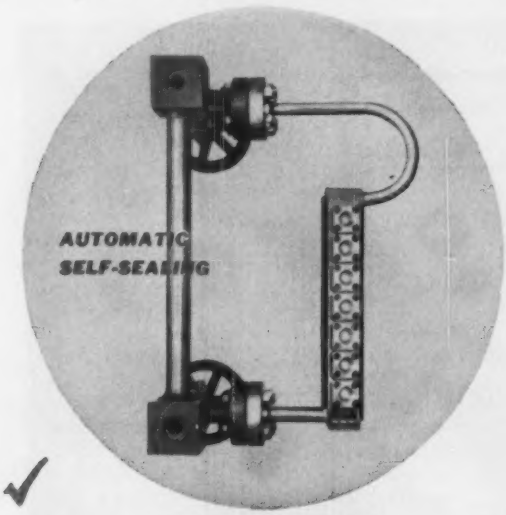
## BLOW-OFF VALVES, LOW PRESSURE

This is the famous blow-off valve with no seat to score, wear, clog or leak. It's a standard in over 16,000 boiler plants. If your blow-off valves are obsolete or worn, consider new Yarways. Another point—all Yarway design and metallurgical improvements are interchangeable with parts of earlier model Yarway valves. See Bulletin B-427.




## BLOW-OFF VALVES, MEDIUM & HIGH PRESSURE

A new development—the Yarway Medium Pressure Unit Tandem Valve for pressures up to 665 lbs.! A Yarway Seatless Valve and a Yarway Integral Stellite Seat Valve are combined in a forged steel body for rugged dependability. There's no other blow-off valve like it! Ask for Supplement A, Bulletin B-435. For high pressure Yarway Unit Tandem Valves to 3206 lbs., ask for Bulletin B-435.




## WATER LEVEL GAGES

Yarway Color-Port Gages give you a new standard of service convenience and readability for water gages. They are automatically self-sealing, have individual port assemblies that can be replaced in minutes with the gage in the line, and show brilliant red and green readings. All these contribute to greater efficiency. Two lines—medium pressures to 1050 psi; high pressures to 3000 psi. See Bulletin WG-1815.

## REMOTE WATER LEVEL INDICATORS

Yarway Remote Water Level Indicators have new "wide-vision" faces, can be pressure and temperature-compensated, may be used under Code Case #1155, can be equipped with remote lights or horn signal alarms or electronic secondary indicators. Add these features to your plant for greater safety and convenience. See Bulletin RI-1825.

# CHECK-UP TIME AGAIN!

can help improve your steam plant efficiency

## HIGH PRESSURE/HIGH TEMPERATURE VALVES

Scores of high pressure/high temperature valve applications call for the Yarway Welbond Valve. Only Welbond combines such features as non-pitting stainless-steel valve stem, non-distorting integral stellite seat and self-aligning disc, special inhibited packing, accessible working parts. Two lines—1500 psi and 2500 psi. See Bulletin B-454.

## STEAM TRAPS

Modern Yarway Impulse Steam Traps will improve efficiency of your power plant and reduce maintenance. The Yarway Impulse Trap features only one moving part, is good for all pressures, has stainless steel construction, small size and light weight, is quick heating, and non-freezing. There is now a Yarway Impulse Trap for every steam plant application—indoors and out. See Bulletin T-1743.

## EXPANSION JOINTS

"Boiler check-up time" is "steam line check-up time," too! Yarway Gun-Pakt Expansion Joints offer unequalled features in slip-type joints. Repacked under full steam pressure with no shut-downs or service interruptions. New one-piece design for body and gland. New convenient arrangement of packing guns. Durable chromium-plated seamless steel sleeves. Positive alignment. See Bulletn EJ-1917.

***THESE FREE ARTICLES WILL HELP YOU IN YOUR JOB. Write for them.***

**"BLOW-OFF VALVE MAINTENANCE"**
Reprint of recent article by Yarway Engineer, E. F. Finsel

**"PACKAGE COMPONENTS SIMPLIFY BOILER PORT GAGE MAINTENANCE"**
Reprint of magazine article by Yarway Engineer, R. D. Neyer

**"DESIGN PROCEDURE FOR SLIP-TYPE EXPANSION JOINTS"**
Reprint of new article by Yarway Engineer, Kenneth S. Roberts

**"HOW ROUTINE MAINTENANCE KEEPS STEAM TRAPS ON THE JOB"**
Helpful, timely article by Yarway Engineer, L. G. Chase

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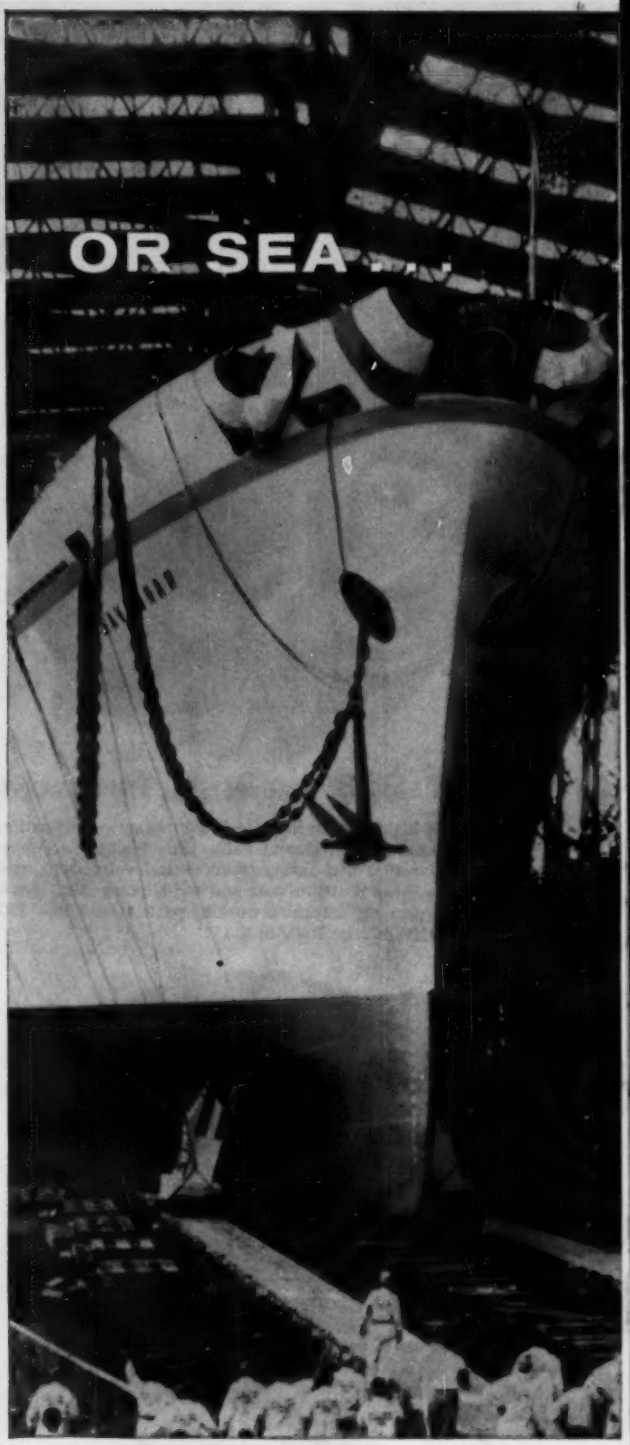
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
*A MARK OF QUALITY IN STEAM ENGINEERING*


For more facts circle 207 on Reader Service card, p 103

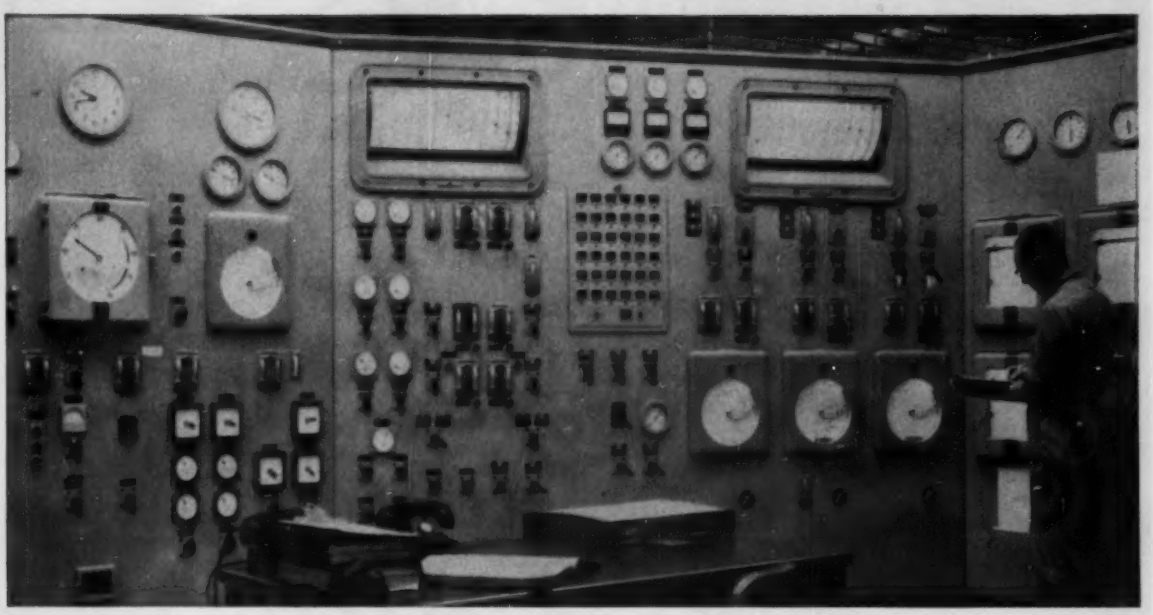
At Milliken Station, New York State Electric and Gas Corporation, Bailey METROTYPE Information Systems monitor operating conditions and gather performance data. The monitoring system continuously scans all points and prints out any off-normal measurements while the performance system makes hourly logs and simultaneously produces punched tape for future use in standard digital computing facilities.




The NS Savannah, first Nuclear merchant ship, is controlled from a "Bailey Board" which includes Nuclear Instrumentation and Bailey Reactor Controls as well as Bailey Steam Plant Instruments and Controls.

This is the control center for the first commercial super-critical pressure, steam-electric unit in America. Here at the Philo plant of the Ohio Power Company, on the American Electric Power Company System, Bailey controls maintain the desired rate of steam generation, final steam temperature and optimum combustion conditions.

# IT'S BAILEY. . .



## for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to insure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

There's a Bailey District Office or Resident Engineer close to you. Check your phone book, or write direct.

A143-2

*Instruments and controls for power and process*

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For more facts circle 208 on Reader Service card, p 103

DOW | **SARAN LINED PIPE**

# "Hungry" water starves in Saran Lined Pipe

Steam turbines require water so pure that processors call it "hungry" — it absorbs impurities from any iron pipe that carries it. These metal contaminants in turn clog the turbine blades, can increase fuel cost as much as 12%. But Saran Lined Pipe travels the "hungriest" water from source to turbine without adding impurities, without corrosive pipe wear. For an example . . .

Gulf States Utilities Company's year-old Roy S. Nelson Power Station at Westlake, Louisiana, designed and constructed by Stone & Webster Engineering Corporation, produces over 200,000 kilowatts for residential, commercial, industrial and agricultural uses. This plant uses 2800 feet of Saran Lined Pipe to move acid and caustic treated well water for purification prior to steam conversion. Its battery of softeners and demineralizers produces 400 gallons of chemically pure water per minute.

Projected studies indicate, in spite of the action of caustic, sulphuric acid and the 120°F. water temperatures, the use of Saran Lined Pipe will reduce pipe replacement by 50%, while protecting the turbines from impurities.

Whenever dependable piping systems are required, whatever the degree of corrosion or chemical activity, consider Saran Lined Pipe. Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200°F. They're easily cut, fitted and modified in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 2502DW6.

**THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN**



For more facts circle 209 on Reader Service card, p 103

# You can use this new Foxboro pneumatic transmitter on six different process measurements

## pressure – temperature – liquid level – differential pressure – dew point – flow... all six with guaranteed accuracy of ±½ of 1%

Think of it . . . a universal pneumatic transmitter with matched elements for six different process variables. That's the new Foxboro M/45 pneumatic indicating transmitter.

And with the M/45 you get: *universal* high accuracy-guaranteed at ±½ of 1%; *universal* ambient temperature stability — less than ½ of 1% in 50°F temperature change; *universal* calibration and simplicity of servicing. A remarkable combination of versatility and uniformity in a single instrument.

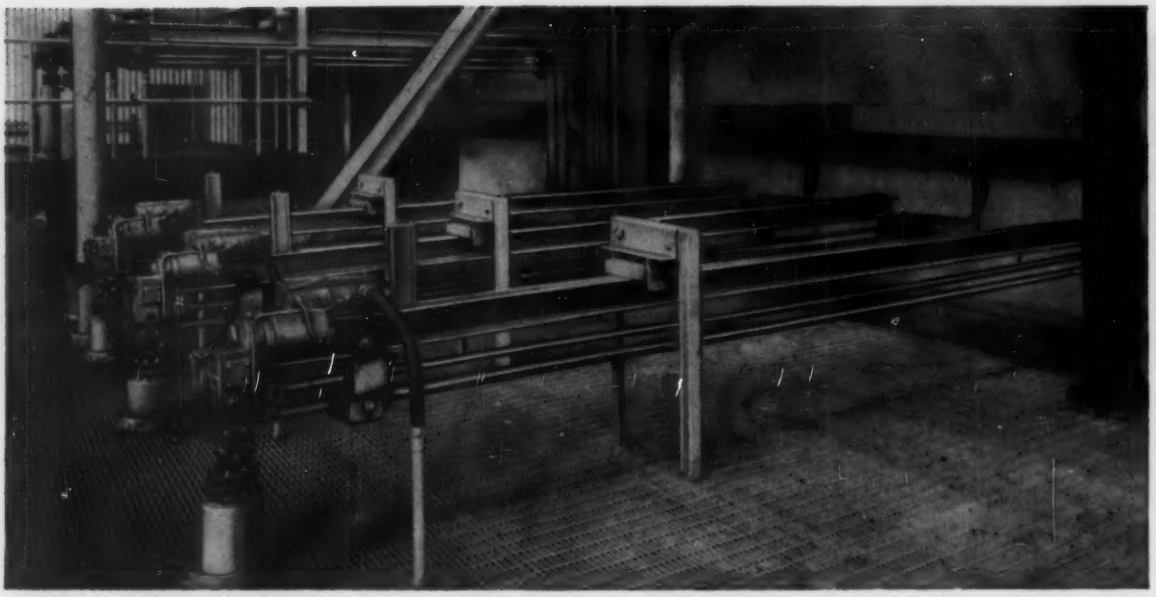
The new Foxboro M/45 indicating transmitter can extend the benefits of standardization throughout your whole plant operation. Ask your Foxboro field engineer to tell you about it. Or write for Bulletin 13-30. The Foxboro Company, 686 Neponset Ave., Foxboro, Mass.

FOXBORO

REG. U.S. PAT. OFF.



For more facts circle 210 on Reader Service card, p 103



# Vulcan Automatic-Sequential System controls soot blowing at new Gannon Station

As the first modern utility boiler in Florida to be fired by coal, Tampa Electric Company's Gannon Station incorporates the most advanced control systems. Unit 1, with its boiler rating at 950,000 pounds per hour at 1760 psig and 1000 degrees F., uses a Vulcan soot blowing system that features both group and unit control.

Vulcan T-3-E long retractable soot blowers with their dual-motor drives, clean Gannon's Unit 1 boiler with double-helix patterns for complete coverage. The system includes Vulcan wall deslaggers and rotary soot blowers—all driven by electric motors and using steam as the blowing medium.

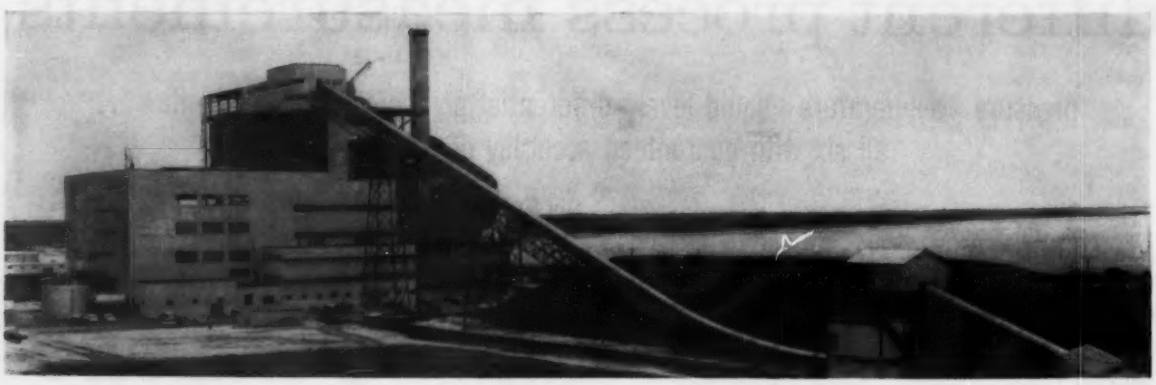
A Copes-Vulcan diaphragm valve reduces steam pressure for blowing and a Copes-Vulcan motor-operated valve is used for shut-off.

A similar Vulcan system will be installed on Gannon's Unit 2, rated at 950,000 pounds per hour at 1760 psig and 1000 degrees F.

Copes-Vulcan offers complete systems for controlling combustion, feedwater, boiler feed pump recirculation, steam temperature, and soot blowing. Whether your boiler is large or small, power or process, Copes-Vulcan can provide a unit or an integrated package, custom designed to your needs. For details, write Copes-Vulcan Division, Erie 4, Pa.

*Copes-Vulcan Division*

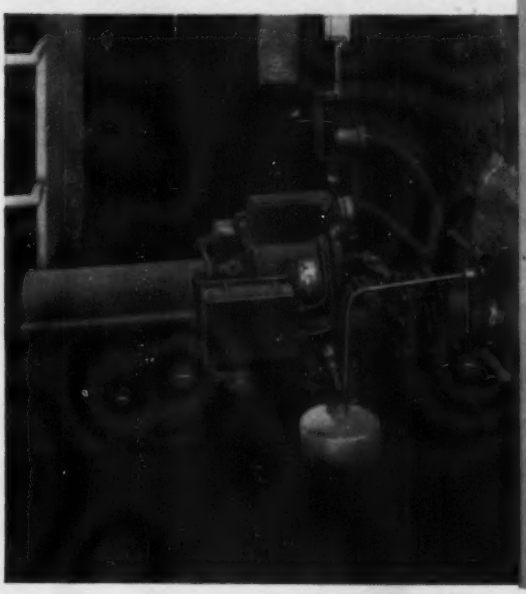
**BLAW-KNOX**

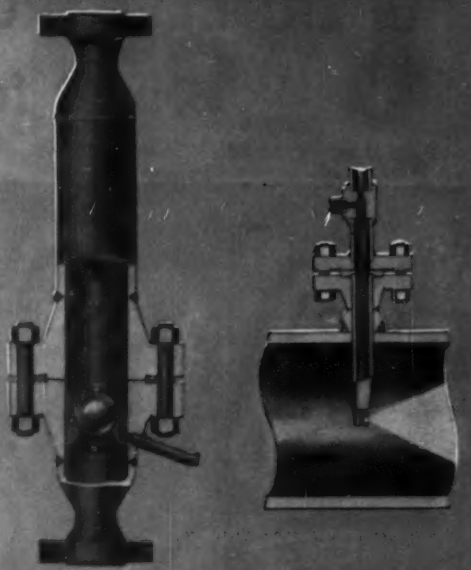


# C-V NEWS NOTES

**Finger tip control for Gannon's operators** . . . with Vulcan's Automatic-Sequential group and unit control. Operator can preselect any number of soot blowers for automatic sequence . . . preselect any number of units or groups of units to be operated individually . . . or switch instantly to single unit operation. Program lights and toggle switches are located on engraved boiler diagram. Automatic-Sequential systems use steam, air or a combination as the blowing medium without a change in equipment. Write for Bulletin 1029.

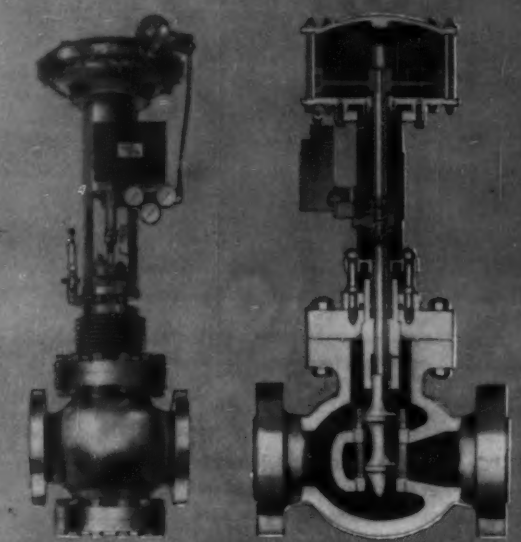
**Wall deslagger conserves steam** . . . minimizes average slag thickness. Vulcan's RW-3E is equipped with dual motors: one to traverse *fast* to get the nozzle to and from the blowing position almost instantly . . . the other to rotate the tube slowly for thorough cleaning. The RW-3E may be installed indoors or out, at almost any angle from side wall, roof or floor. It has only one outside stuffing box, no threads or working parts in the blowing medium to assure easy maintenance. Write for Bulletin 1034.





**Desuperheaters improve temperature control.** Variable-Orifice Desuperheater* (left) uses a weighted steel ball to control orifice opening . . . holds reduced steam temperature constant only twenty feet downstream from desuperheater outlet, even over a 50-to-1 load range. Bulletin 1037. *Patent Applied For

**Steam-Assist** (right) meets all specifications for conventional steam-atomizing type yet normally uses assisting steam only on light loads where control is most difficult. Mechanical-atomizing types also available. Bulletin 1024-A.



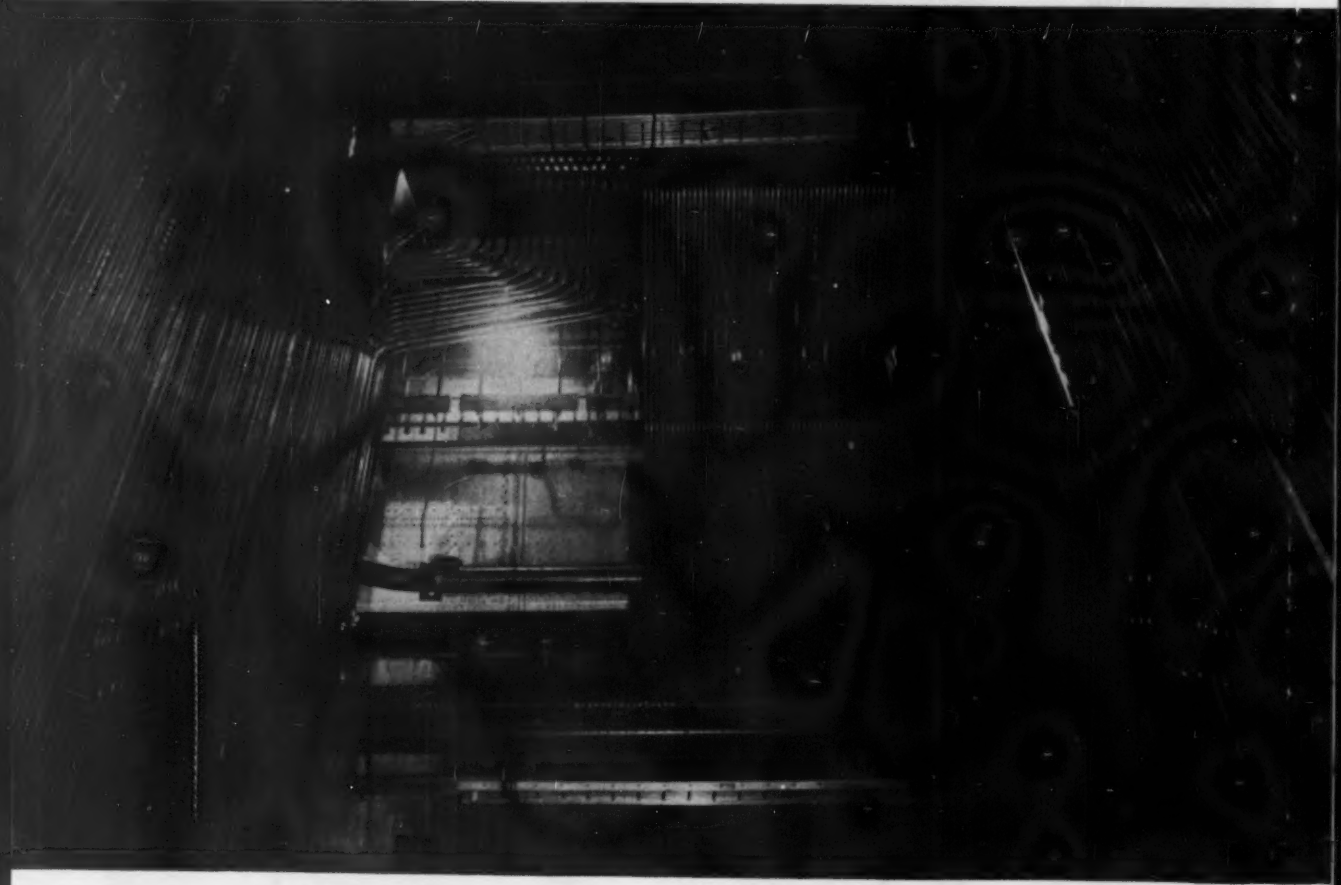
**Versatile regulator valves** offer new simplicity of design. Diaphragm-type CV-D (left) is designed for remote control service. It can be direct or reverse acting, has excellent rangeability. Piston-type CV-P (right) is designed for high-duty service . . . assures maximum power with precise positioning.

**All Copes-Vulcan** valves are tailored to the job. The style of valve port is selected to provide optimum control for specified operating conditions. Bulletin 1027.

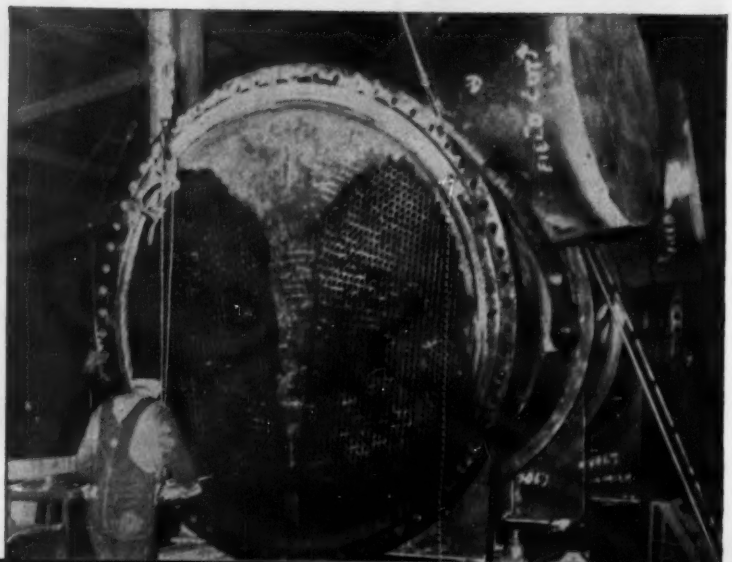


For more facts circle 211 on Reader Service card, p 103

# REPUBLIC ELECTRUNITE BOILER TUBES
## ...heat for the heart of Detroit



"Corrosion or erosion problems in surface, feed water condensers heaters, deaerators, vent condensers, or pure water lines are solved by Republic ELECTRUNITE STAINLESS STEEL TUBING."



Meeting heat and power demands of a big city is an important job keyed to dependability. At Detroit Edison's Beacon Heating Plant in Detroit, dependable heat and power is assured by a new steam generator having an operating capacity of 500,000 lbs. per hour. It was designed, engineered, and constructed by Combustion Engineering Company, New York City, and uses Republic ELECTRUNITE® Boiler Tubes.

ELECTRUNITE is specified for the big jobs because dependability is built-in. The ELECTRUNITE process assures uniform wall thickness, uniform ductility, uniform diameter, and true concentricity. Bends are smooth and uniform. Rolling-in operations easier.

ELECTRUNITE is universally accepted by leading technical authorities, code societies, boiler and heat exchanger manufacturers. ELECTRUNITE is hydrostatically or electronically tested to conform with applicable ASTM specifications, the ASME Boiler and Pressure Vessel Code, and boiler insurance requirements.

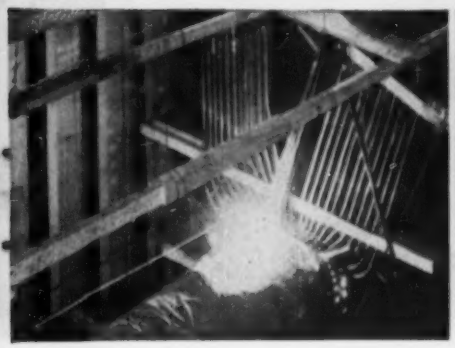
For boiler, heat exchanger, condenser, or evaporator tubes, get ELECTRUNITE facts first-hand from your Republic representative. Call, or send coupon below.

**FARROWTEST®—QUALITY YOU CAN MEASURE.** Not a laboratory theory, not a mere inspection tool, but an exclusive production test that detects and rejects tubing containing defects of critical size. FARROWTEST is offered as an alternative to other less positive tests in accordance with table below, at no extra cost.

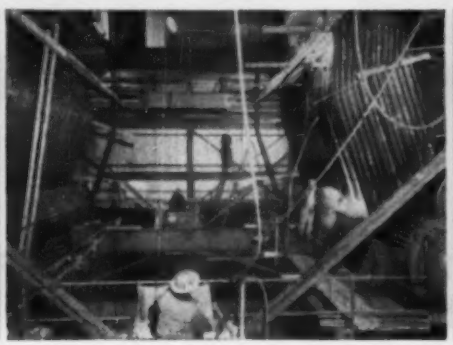
**FARROWTEST REJECT TABLE**

| Wall Thickness (B.W. Gage) | Minor dimension of the defect (Length or Depth) | Defective Area (Length, Depth Plane) |
|---|---|---|
| 20 | .006" | .0025 sq. inches |
| 18 | .006" | .003 sq. inches |
| 16 | 12½% of wall | .003 sq. inches |
| 14 and 13 | 12½% of wall | .004 sq. inches |
| 12 and heavier | 12½% of wall | .005 sq. inches |

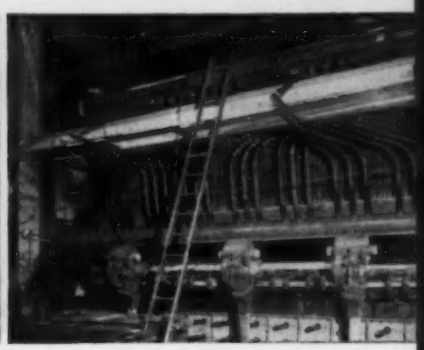
FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.



**DETROIT EDISON COMPANY** Beacon Heating Plant, showing installation of Republic ELECTRUNITE Boiler Tubes in North drums.



**REPUBLIC ELECTRUNITE BOILER TUBES** are able to withstand tremendous temperatures because dependability and quality are built-in.



**ELECTRUNITE** uniformity and ductility . . . view from operating floor showing stoker erection and front wall of boiler.

REPUBLIC

# REPUBLIC STEEL

*World's Widest Range of Standard Steels and Steel Products*

**For more facts circle 212 on Reader Service card, p 103**

**REPUBLIC STEEL CORPORATION**
**STEEL AND TUBES DIVISION**
**Dept. C-9210**
**221 EAST 131st STREET • CLEVELAND 8, OHIO**

Please send more information on the following products:

☐ Republic ELECTRUNITE Boiler Tubes
☐ Republic ELECTRUNITE Heat Exchanger Tubes
☐ Carbon ☐ Stainless ☐ FARROWTEST Brochure

Name_____ Title_____

Company _____

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City _____ Zone____ State_____

**SELECTIVITY CURVES** *show tripping times for all breakers in your G-E Load Center—your assurance of SELECTIVE COORDINATION under all conditions. Ask for them.*

## *Selectively Coordinated* Load Centers Deliver . . .

# Best Service Continuity Under All Conditions

### . . . Yet you pay no price premium if you buy from General Electric

***SELECTIVE COORDINATION GIVES BEST SERVICE CONTINUITY***

SELECTIVELY COORDINATED Load-Center Unit Substations are your best assurance of power continuity. Power circuit breakers are factory-preset by General Electric so that—during short-circuit conditions—only the circuit breaker on the faulted feeder opens. Power continues to flow through unfaulted circuits to the rest of the loads. This "selectivity" between main and feeder breakers is accomplished by coordinating the tripping time of the main and feeder breakers.

During any magnitude of feeder short circuit, the main breaker "waits" until the feeder breaker opens.

***YOURS AT LOWER COST***

You now can have this superior coordination at no extra cost. Advanced engineering techniques by General Electric have eliminated the price premium normally charged for this inherently higher cost, more highly-engineered unit substation. In addition, you can save by using manually operated, stored-energy breakers in place of electrical units which were formerly required.

This means that General Electric SELECTIVELY COORDINATED load centers are now available at the same price as the fully rated load centers.

***ONLY CURVES PROVE YOU HAVE SELECTIVE COORDINATION***

Specify the SELECTIVELY COORDINATED Load-Center Unit Substation, with coordination curves for the specific breakers in your Load Center. These curves will show you how time-current characteristics combine to assure you of maximum power service continuity.

For more detailed information, contact your nearest General Electric Apparatus Sales Office, or write to General Electric Co., Schenectady 5, New York for publication GEA-3592. 331-02

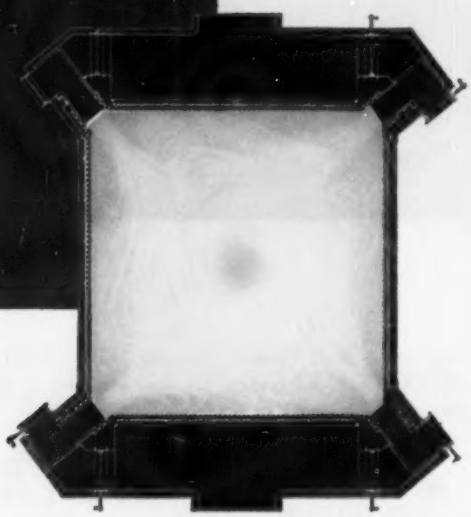
*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**

# TANGENTIAL

Looking up into the furnace of a C-E Controlled Circulation Boiler. One of its four Tilting, Tangential Burners is being moved into position. The burner and its adjacent water wall tubes are shop assembled into a single panel and handled as one piece. All four corners of the furnace are similarly equipped. Tangential burners may be arranged to burn coal, oil or gas separately or in combination.

Sectional plan view through tangentially fired furnace showing impinging action of fuel streams from the burners which results in extreme turbulence and thorough mixing of fuel and air.



## COMBUSTION

**Combustion Engineering Building**

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

# FIRING...
# best for big boilers

Tangential firing – an exclusive C-E development–was introduced by Combustion in 1927. The tilting feature of the burner nozzles, for control of superheat temperatures, was added to the basic design in the late thirties. Among the many proven advantages of the C-E Tilting, Tangential Burner, those enumerated below are especially noteworthy – whether the fuel be coal, oil or gas, or combinations thereof.

## Combustion is better

1. The extreme turbulence created by impinging flame streams of adjacent burners assures the most effective mixing of all the air with all of the fuel to produce the most rapid and complete combustion. Minimum carbon loss is assured.
2. The swirling rotating travel of combustion gases fills the furnace cross-section and utilizes the heat absorbing wall surfaces most effectively.

## Superheat is controlled

1. If steam temperature goes too high, the C-E Tilting Tangential Burner nozzles automatically tilt downward. More furnace wall surface becomes effective. Gas temperature to superheat surface is lowered. Steam temperature comes down.
2. Conversely, if steam temperature drops below that efficient for the turbine, nozzles tilt upward, sending hotter gases to the superheater. Steam temperature goes up – automatically.

## Acceptance is widespread

About 650 tangentially fired C-E Boilers with an aggregate capacity of about 400-million pounds of steam per hour are now in service; another 85 units are under construction or on order. In 1959 alone 31 new C-E Boilers with an aggregate capacity of over 5-million kilowatts were put in operation in electric utility plants. All of these units are tangentially fired.

Thus, tangential firing has established itself in service over a period of many years as the most widely accepted method of firing for big boilers. More recently it has met similar success in smaller oil and gas fired units for capacities as low as 70,000 lbs. of steam per hour. Catalog PC 8 gives full information. May we send you a copy?

**ENGINEERING**

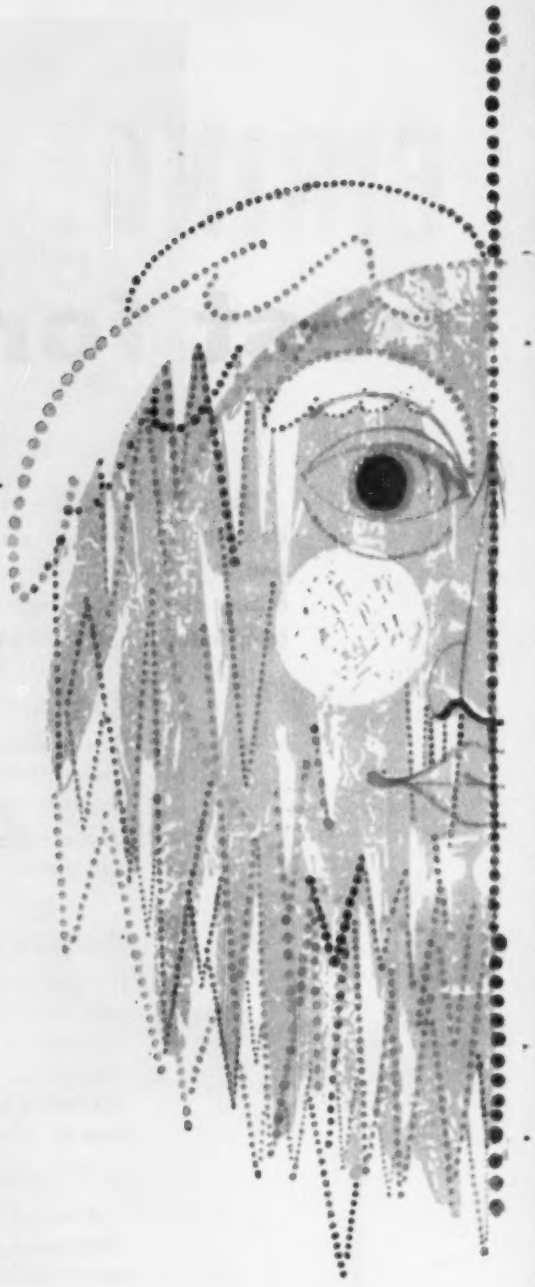
200 Madison Avenue, New York 16, N. Y.

C-263

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

# You can meet any combination of temperature and weather with J-M

- cements
- jackets
- coatings
- fills



Along with the widest assortment of industrial insulations available, Johns-Manville offers a full line of cements, jacketing materials, coatings and fills. These important accessory items have been specially developed for use with J-M insulations to withstand both high process temperatures *and* exposures to all kinds of weather extremes on the job.

Don't settle for half a specification. Let your insulation contractor furnish the right combination of Johns-Manville materials vital to the satisfactory completion of any insulation job.

More than a century's experience in development and manufacture of top quality insulating materials insures the ability of Johns-Manville to meet *any* requirements and all extremes of temperature and weather. Talk over your specific needs with your J-M representative, or write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

## JOHNS-MANVILLE

JOHNS MANVILLE JM PRODUCTS

AN INSULATION FOR EVERY COMMERCIAL AND INDUSTRIAL USE

## *See how J-M offers materials to match your specific needs*

**J-M CEMENTS** are designed for insulating or finishing applications. Eight types are made for general and special purpose use from such base materials as asbestos, magnesium carbonate, diatomaceous silica, mineral fiber, expanded vermiculite, hydraulic-setting cement, etc. Temperature limits range as high as 1900F.

**J-M WEATHERPROOFING JACKETS** for fire resistance and weatherproofing can be furnished factory-applied to pipe insulations, or separately for on-the-job installation, in a wide range of thicknesses and weights. Twelve different jackets to choose from—for temperatures to 250F.

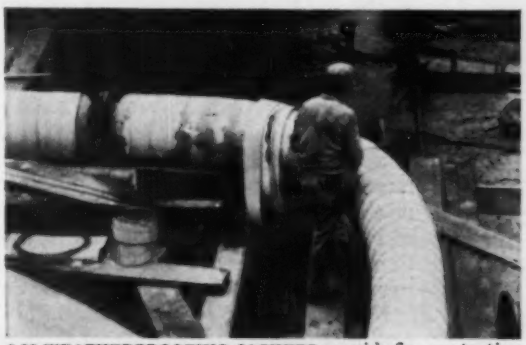
**J-M INSULKOTE®** weather-protective coatings guard insulation against corrosive atmospheres and extremes of weather. Insulkote can be troweled or gunned in place on vessels, tanks, piping and equipment. Available in six types, both "breathing" and "non-breathing."

**J-M FILLS** are recommended for insulating irregular spaces in high-temperature equipment.

*Ask your J-M Insulation Contract Unit about these and the other quality insulating materials by Johns-Manville—your best assurances of long, trouble-free performance on the job.*

**JOHNS-MANVILLE INSULATING** and finishing cements are applied over flat or irregular surfaces to give a smooth, crack-free finish that can easily be painted or given an additional weather-protective coating.

**J-M INSULATING CEMENT** can be applied by troweling in place . . . here, on a large cylindrical vessel previously covered with blanket insulation.



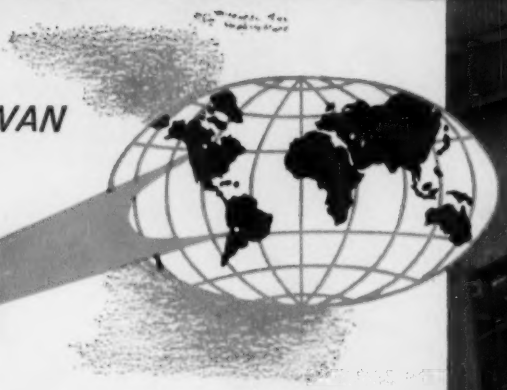
**J-M WEATHERPROOFING JACKETS** provide fire protection and weatherproofing as they meet any hot or cold insulating requirement. Most of the 12 available types are made of asbestos, felt-coated and saturated with asphalt.

**J-M INSULKOTES** can be ready-mixed and applied by trowel or spray gun over wire or Duramesh® fiber glass reinforcements. They effectively seal out moisture to prevent equipment corrosion . . . safeguard insulation investment.



For more facts circle 215 on Reader Service card, p 103

*from URANIUM in SASKATCHEWAN*
*to NITRATES in CHILE . . .*



# NORDBERG ENGINES
## prove their reliability and economy
# in MINING SERVICE

**AT GUNNAR MINES, LIMITED . . .** Neither bitter cold, nor inaccessible location could stop the successful development of a strategically valuable uranium ore deposit by Gunnar Mines, Limited, located in northwest Saskatchewan, less than 450 miles south of the Arctic Circle.

To meet the electrical power requirements for the construction and operation of mine, mill and town facilities, Gunnar chose seven Nordberg Supairthermal® 4-cycle diesel engine-generator units, each rated 1200 hp at 450 rpm, direct connected to 845 kw generators. Adding to the efficiency of this installation are waste heat boilers which utilize exhaust gas from the Nordberg engines to produce steam for heating plant buildings.

**AT ANGLO-LAUTARO NITRATE CORPORATION . . .** The story of power plant expansion for Anglo-Lautaro Nitrate Corporation's vast operations in northern Chile is largely a story of reliable Nordberg power. Their original Nordberg engine was a 7100 hp diesel unit installed in the Pedro de Valdivia plant, followed by the installation of two 1900 hp Nordberg diesels for the plant at María Elena. Then, to meet much needed additional power, two big 9600 hp Nordberg diesels were installed in a new power plant at Coya Sur.

Now Anglo-Lautaro has again turned to Nordberg to meet further power expansion, and has ordered *five more* Nordberg diesels, each rated 5750 hp, to be installed in the Pedro de Valdivia power plant. When these new engines are put in service, the combined generating capacity of all ten Nordberg engines will provide over 38,000 kilowatts for nitrate production.

*While these installations in Saskatchewan and Chile are widely separated geographically, they serve as striking examples of the way in which Nordberg engines are serving the varied power requirements of the mining industry . . . especially in remote areas where dependable operation is of prime importance.*

**NORDBERG MANUFACTURING COMPANY**
Milwaukee 1, Wisconsin

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P959

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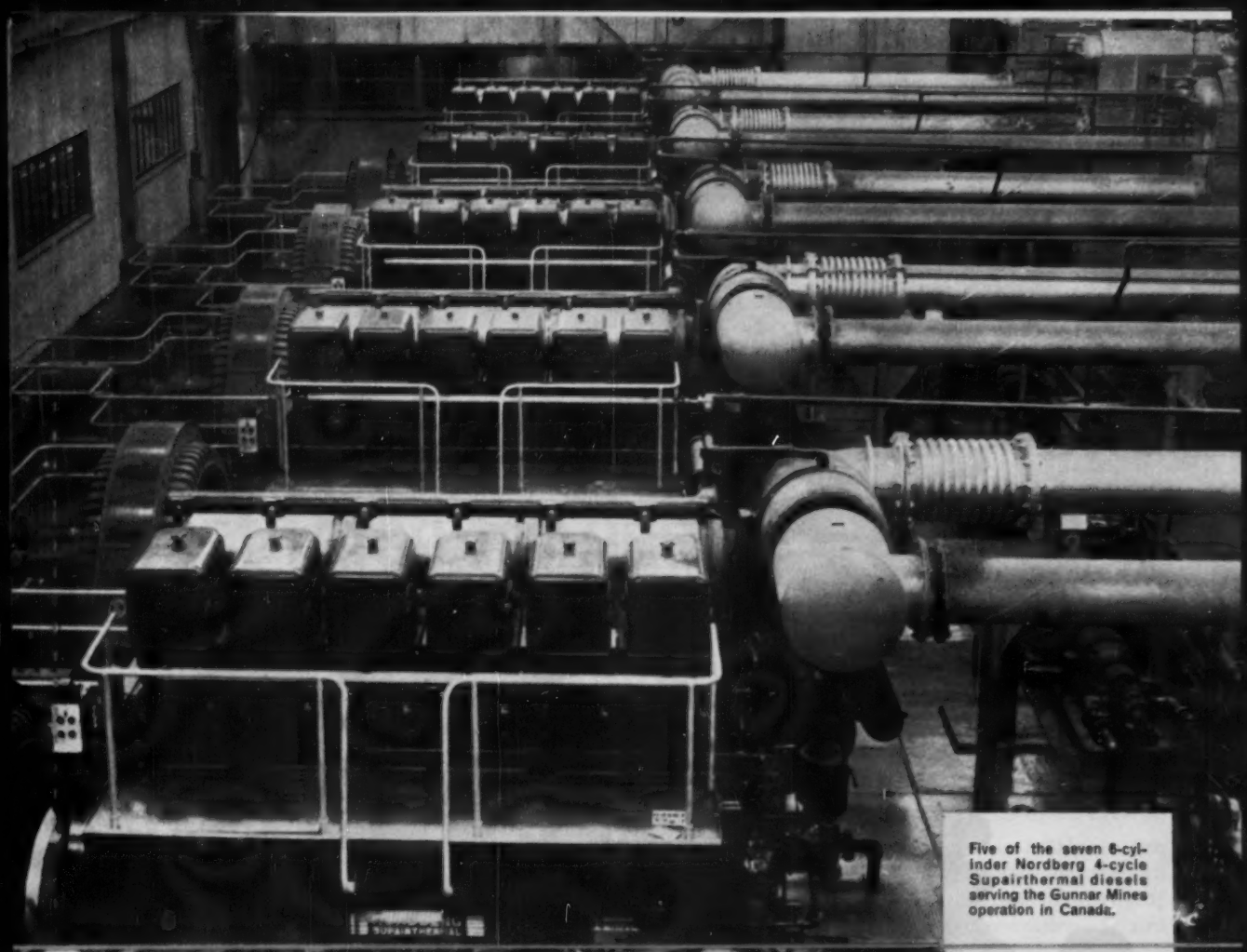
NORDBERG GRINDING MILLS

SYMONS VIBRATING SCREENS

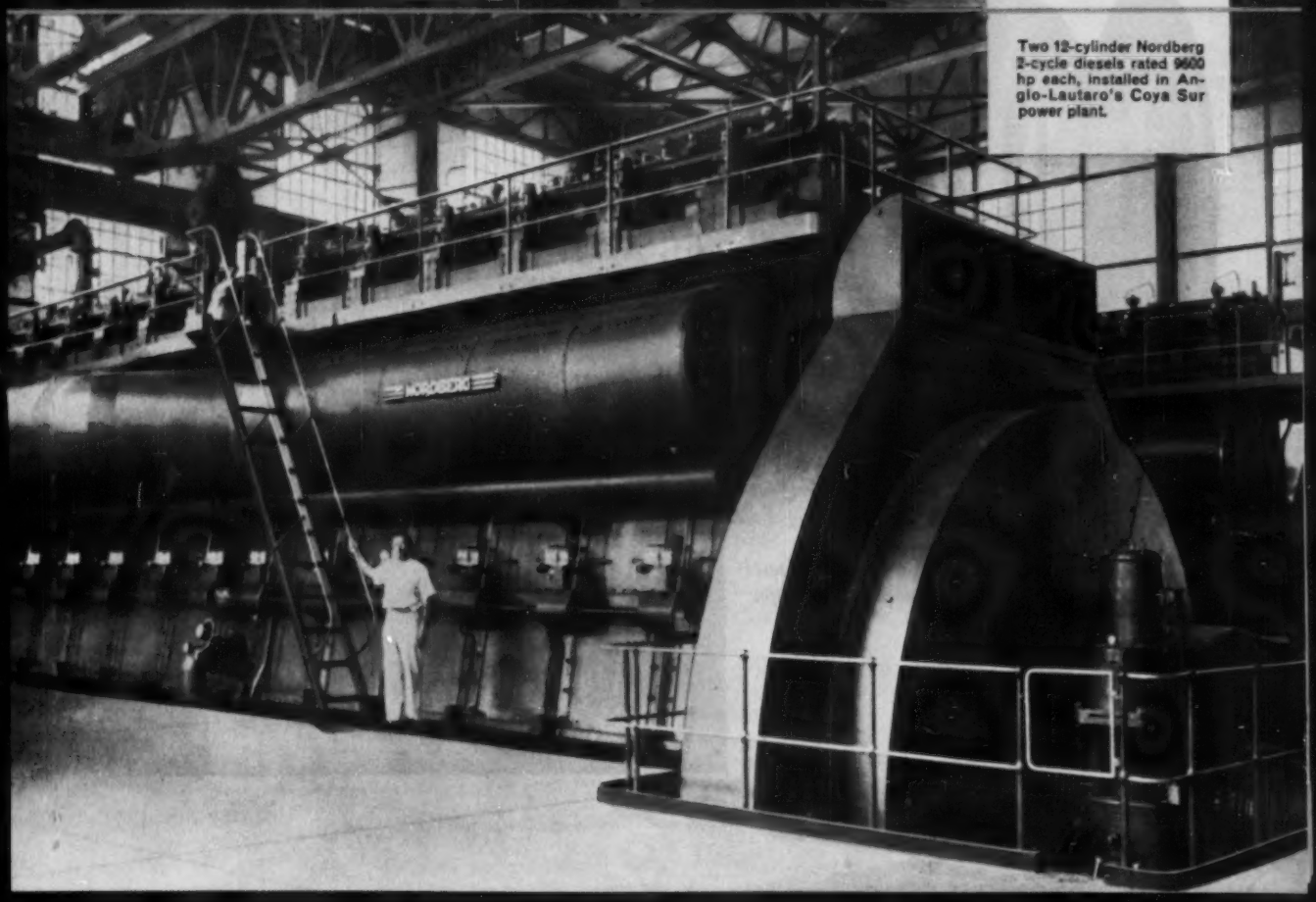
SYMONS VIBRATING GRIZZLIES

NORDBERG MINE HOISTS

For more facts circle 216 on Reader Service card, p 103



Five of the seven 6-cylinder Nordberg 4-cycle Supairthermal diesels serving the Gunnar Mines operation in Canada.




Two 12-cylinder Nordberg 2-cycle diesels rated 9600 hp each, installed in Anglo-Lautaro's Coya Sur power plant.

# NEW...FROM

**TUBE-TURN** *Bellows Expansion Joints are test rated on basis of minimum cyclic life.*

# TUBE TURNS...

## Bellows Expansion Joints test rated for assured cyclic life

Tube Turns has introduced a brand new concept in bellows expansion joints to fill a vital need in engineered piping systems.

These new bellows joints are rated on the basis of thorough, well organized test studies to *assure a definite minimum cyclic life*... rather than the usual average or maximum. This conservative rating, backed by Tube Turns' extensive test results, gives you an assurance of *confidence* heretofore lacking in the application of bellows joints.

Hence, you can specify TUBE-TURN* Bellows Expansion Joints and be sure of predictable performance. These top-quality products will be subject to the same warranties that apply to all other products of Tube Turns.

**Backed by Tube Turns' technical service!** This new line of products is backed by 31 years of pioneering research in piping technology, including problems of piping flexibility. Our sales-engineering representatives, located nearby, will assist in the application of TUBE-TURN Bellows Expansion Joints to your specific problems.

**Complete line.** TUBE-TURN Bellows Expansion Joints are available in sizes 3" through 30"... unreinforced, rated 50 psi ... reinforced, rated 275 psi. Also, expansion compensators for steam and hot water service are available in sizes ¾" through 3". Mail coupon for complete information.

*The trademarks "TUBE-TURN" and "tt" are applicable only to the quality products of Tube Turns.

*Another* tt *plus value from...*

**TUBE TURNS**

DIVISION OF CHEMETRON CORPORATION

**Louisville 1, Kentucky**

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**MAIL FOR CATALOG.** Lists available sizes of TUBE-TURN Bellows Expansion Joints... includes rating tables to guide in piping design. Mail coupon for free copy.

**TUBE TURNS, Dept. PO-6**
**224 E. Broadway • Louisville 1, Kentucky**

Send catalog on TUBE-TURN Bellows Expansion Joints.

*Company Name*_____

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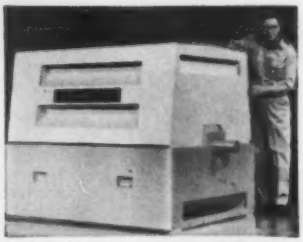
*City*_____ *Zone*____ *State*_____

*Your Name*_____

*Position*_____



For more facts circle 217 on Reader Service card, p 103



MORE VALUE FOR YOUR LARGE MOTOR INVESTMENT . . .

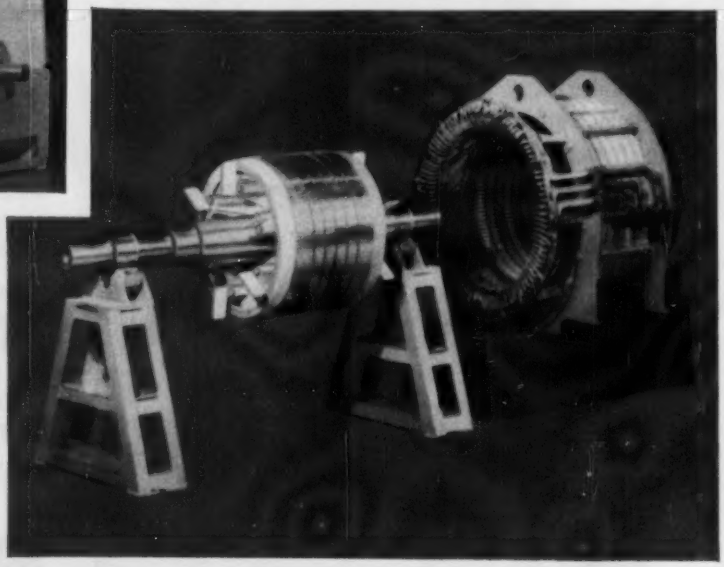
# how Westinghouse F/A Motor design

What's new in inspection procedures for large motors? Less of it . . . up to 75% in both time and dollars directly chargeable to this chore.

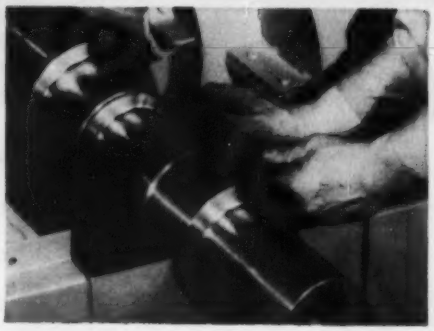
The reason Westinghouse can offer such unusual savings in inspection and maintenance is the revolutionary new F/A Motor design. For the first time, here is full accessibility coupled with the time-tested and -proved reliability of Westinghouse motor components. The motor housing is completely separate from the stator and can be removed in minutes for thorough visual inspection.

This degree of accessibility is impossible with conventional motors. As a consequence, the F/A Motor can be more thoroughly inspected and maintained, thus guaranteeing true value

**Disassembly** as complete as this is impossible in conventional motors. With the Westinghouse F/A Motor it *can* be done, and in only 90 minutes. Reassembly takes only 2 hours, for a total of 3½ hours for a complete dismantling.



**Inspection of leads** and connections is simple. There are no protruding conduit boxes; cable comes up through the base, leaving plenty of room for connecting motor leads.



**For routine inspection** of windings and bearings, simply remove the end panels (above). **For complete bearing inspection,** merely remove bearing cap, top bearing shell and oil ring; then bottom bearing shell rolls out for easy inspection (right). **For more thorough inspection,** end covers, panels and air shields can be removed in only 38 minutes and replaced in 56—with the motor still in running condition!

YOU CAN BE SURE...IF IT'S



For more facts circle 218 on Reader Service card, p 103

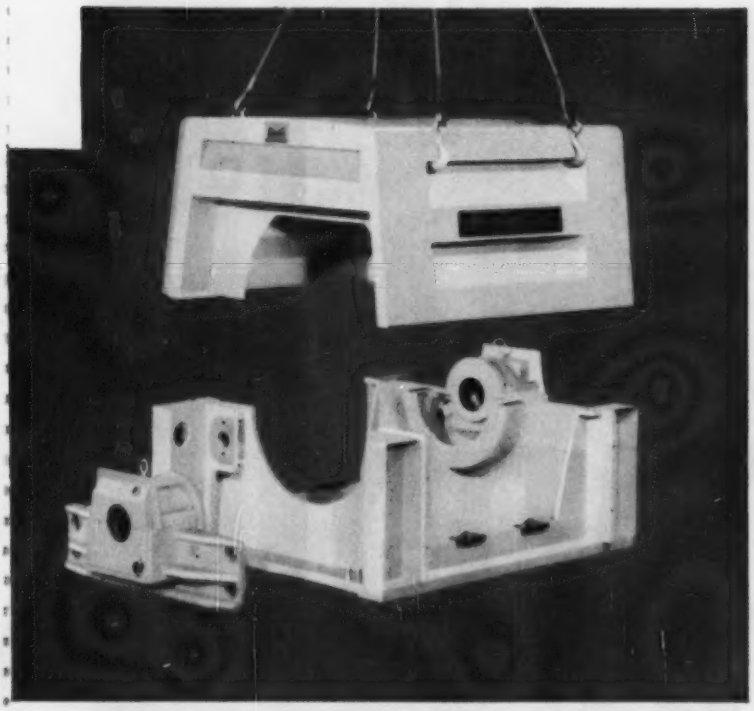
# cuts inspection time and costs as much as 75%

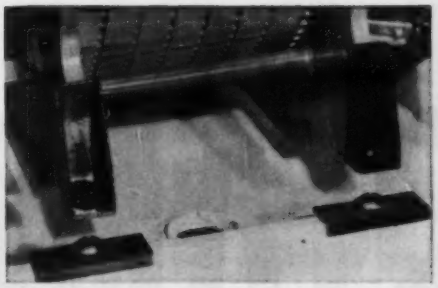
and long life for your large motor investment. Speedier work saves up to 75% of the man-hours and money usually expended in these procedures. Outages, too, are fewer and shorter.

**In addition, these bonus values are yours in the F/A Motor**—Thermalastic® insulation, with super-reliability proved in over 50 million kw of Westinghouse large rotating apparatus since its development 11 years ago; extra quietness, virtually eliminating the shrill screech of the typical large motor.

You'll want more information on this most modern of all large motors. Call your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-15016





**Special ball-and-socket** type locator joints simplify removal and replacement of stator in annual inspections. In reassembly, perfect realignment is automatic.

## COMPARE! How much time are you spending on large motor inspections?

USE THIS SIMPLE CHART TO MAKE YOUR OWN COMPARISON TESTS!

| INSPECTION OPERATION | TIME—F/A MOTORS | TIME—YOUR MOTORS |
|---|---|---|
| Routine: Including windings, bearings and leads. | Removal of panels and shields—38 min.<br>Replacement—56 min. | |
| Annual: Including complete teardown. | Disassembly—90 min.<br>Reassembly—120 min. | |

# Westinghouse

TUNE IN WESTINGHOUSE-CBS TV-RADIO COVERAGE, PRESIDENTIAL CONVENTIONS, JULY 10-29

# RED, HOT AND STANDARD

# NEW

## With the Big 7 features to give you better engine performance and lower maintenance costs

**Here's how you get better engine performance**

Balanced volatility gives you maximum usable power. It allows PREMIER Diesel Fuel to deliver the most possible BTU's of energy without sacrificing clean-burning qualities, meanwhile assuring low smoke and exhaust odor. PREMIER's low pour point means free flow in cold weather. PREMIER's cetane means that engines start easily, idle smoothly, deliver full performance under all operating conditions.

PREMIER's anti-rust additive minimizes an important diesel engine worry—injector sticking. PREMIER Diesel Fuel is handled only by Standard Oil from refinery to you, thus the chance of fuel contamination is virtually eliminated.

**Here's how you get lower maintenance costs**

Deposits caused by excessive sulfur in fuel can damage the engine and increase maintenance costs. PREMIER's low sulfur content means reduced engine wear. Additives inhibit rust of engine parts and storage facilities. PREMIER's just-right viscosity results in effective injector lubrication and the prevention of leakage. Because of this you don't waste fuel or power.

Get all the facts about new PREMIER Diesel Fuel. Call your nearby Standard Oil office. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

# PREMIER DIESEL FUEL

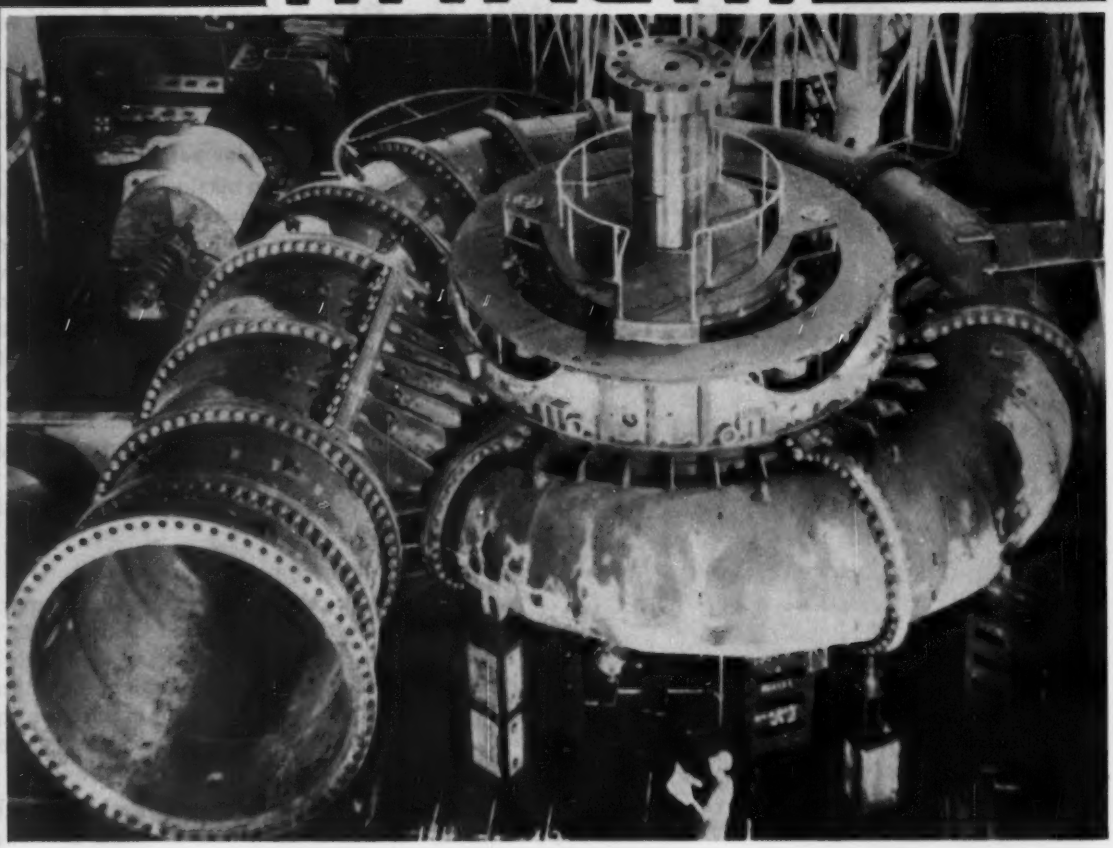
**Here are the 7 big features**

1. Anti-rust additive.
2. Balanced volatility—for full power and clean burning.
3. Cetane—for easy starting, good performance.
4. Free flowing—even in cold weather.
5. Low sulfur—less wear, reduced deposits.
6. Lubricates and seals injectors.
7. Distinctive red color.

*You expect more from* **STANDARD** *and you get it!*

For more facts circle 219 on Reader Service card, p 103

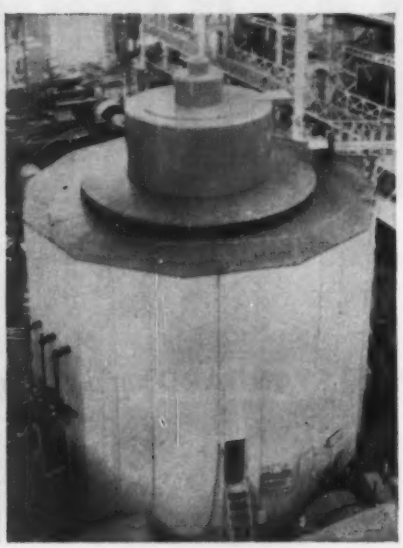
# HITACHI



## Another big Hydraulic Turbine and Generator by Hitachi

Hitachi has recently completed two 137,500kw/125,000kVA hydraulic turbines and generators for the Miboro Power Station in Central Japan.

The turbine is of the vertical-shaft Francis type, and specified for a speed of 225rpm, a maximum effective head of 200m and 76.6 cu.m/sec water flow, making it one of the largest units of its kind in the world. Its runner has a maximum diameter of 3.7m and the main shaft a diameter of 95cm. The spiral casing, which was constructed in 13 sections to facilitate transportation to the site, has an inlet diameter of 3.35m and an outer diameter of 11.2m.



The generator presents a high-torsoed appearance as shown in the photograph, having been so designed in consideration of the comparatively high speed. Since the generator was designed for a rated voltage of 16,500 volts and, in this respect, represents the first such attempt in Japan, particular care was taken in the corona-shielding and impulse resistance of the stator winding.

The generator is rated at 60 cycles, 225rpm and 0.9 power factor but is also capable of operating at 50 cycles, 187.5rpm and 1.0 power factor.

Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHY" TOKYO


For more facts circle 220 on Reader Service card, p 103

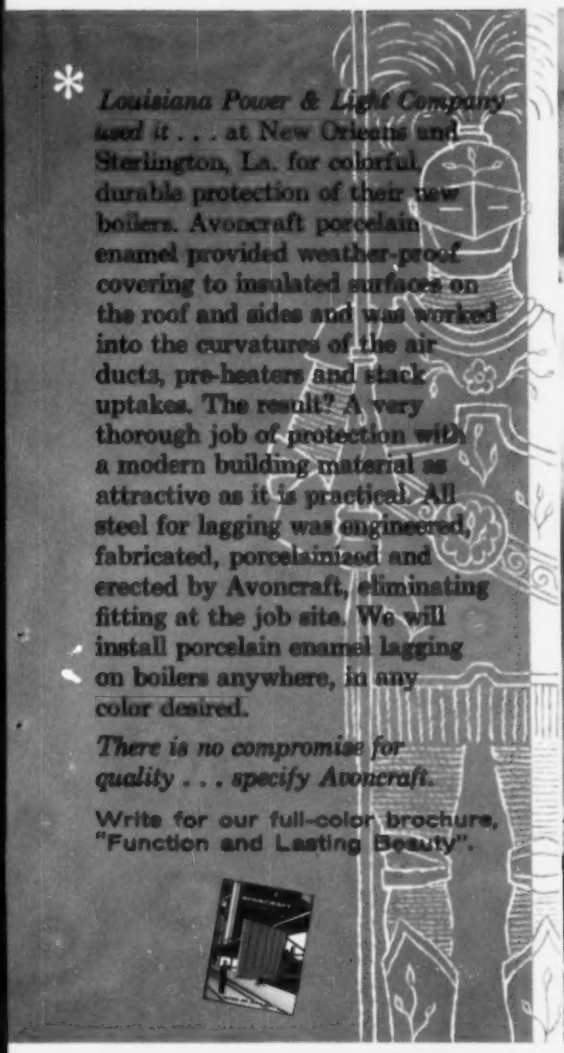
For more facts circle 221 on Reader Service card, p 103 ▶

*a modern suit of armor . . .* *

**for power installations**

# AVONCRAFT

ARCHITECTURAL PORCELAIN ENAMEL

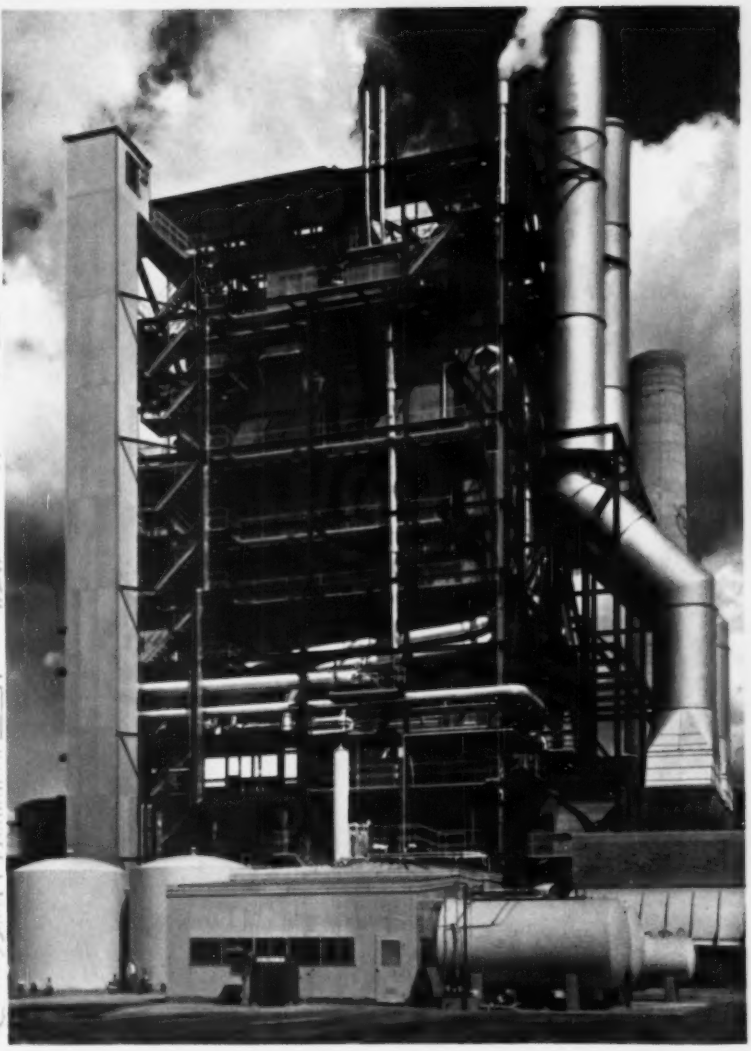


* *Louisiana Power & Light Company used it* . . . at New Orleans and Sterlington, La. for colorful, durable protection of their new boilers. Avoncraft porcelain enamel provided weather-proof covering to insulated surfaces on the roof and sides and was worked into the curvatures of the air ducts, pre-heaters and stack uptakes. The result? A very thorough job of protection with a modern building material as attractive as it is practical. All steel for lagging was engineered, fabricated, porcelainized and erected by Avoncraft, eliminating fitting at the job site. We will install porcelain enamel lagging on boilers anywhere, in any color desired.

*There is no compromise for quality . . . specify Avoncraft.*

Write for our full-color brochure, "Function and Lasting Beauty".





**AVONCRAFT**

a division of **AVONDALE** MARINE WAYS, INC.

P. O. BOX 1030 • NEW ORLEANS, LA.

## *for this type service . . . specify this* **STRONG** *trap:*

Dirty Lines or Dirty Steam:

Lowest Initial Cost per pound capacity:

Lowest Initial Cost per pound weight:

Eliminating Large Volumes of Air:

HYDRO-FLEX INVERTED BUCKET TRAP

FLOAT & THERMOSTATIC TRAP

Low Pressures with some air elimination:

Pulsating or Widely Varying Pressures:

OPEN BUCKET TRAP

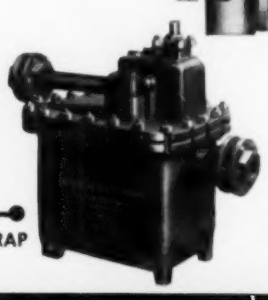
Continuous flow required:

BALL FLOAT TRAP

Draining a line carrying a vacuum discharging to atmosphere:

TYPE "A" VACUUM TRAP

Draining a line carrying a vacuum or very low pressure discharging against a hydrostatic head or back pressure:



TYPE "M" VACUUM TRAP

*on every type service*

# STRONG steam traps give you longer life, less maintenance

Strong offers six types of steam traps to answer every requirement for removing condensate from all types of systems.

You can specify these Strong Traps with the assurance that you will get maximum service life. Proof is the fact that replacement parts are still being ordered for traps sold 50 years ago!

Here are some low maintenance features built into Strong Traps. Screwed-in, replaceable valves and seats of wear-resistant ANUM-METL. Deep-drawn, one-piece stainless steel buckets. Extra-heavy body and cover construction. Thorough testing. Interchangeable parts.

You will be money and years ahead when you specify Strong Traps. For further information, contact your local Strong distributor — he carries complete stocks and replacement parts, offers prompt service.

Selector Chart in Strong Catalog No. 69A gives trap recommendations for 45 types of equipment. Write for your copy or call your distributor.

4/S

## STRONG, CARLISLE & HAMMOND

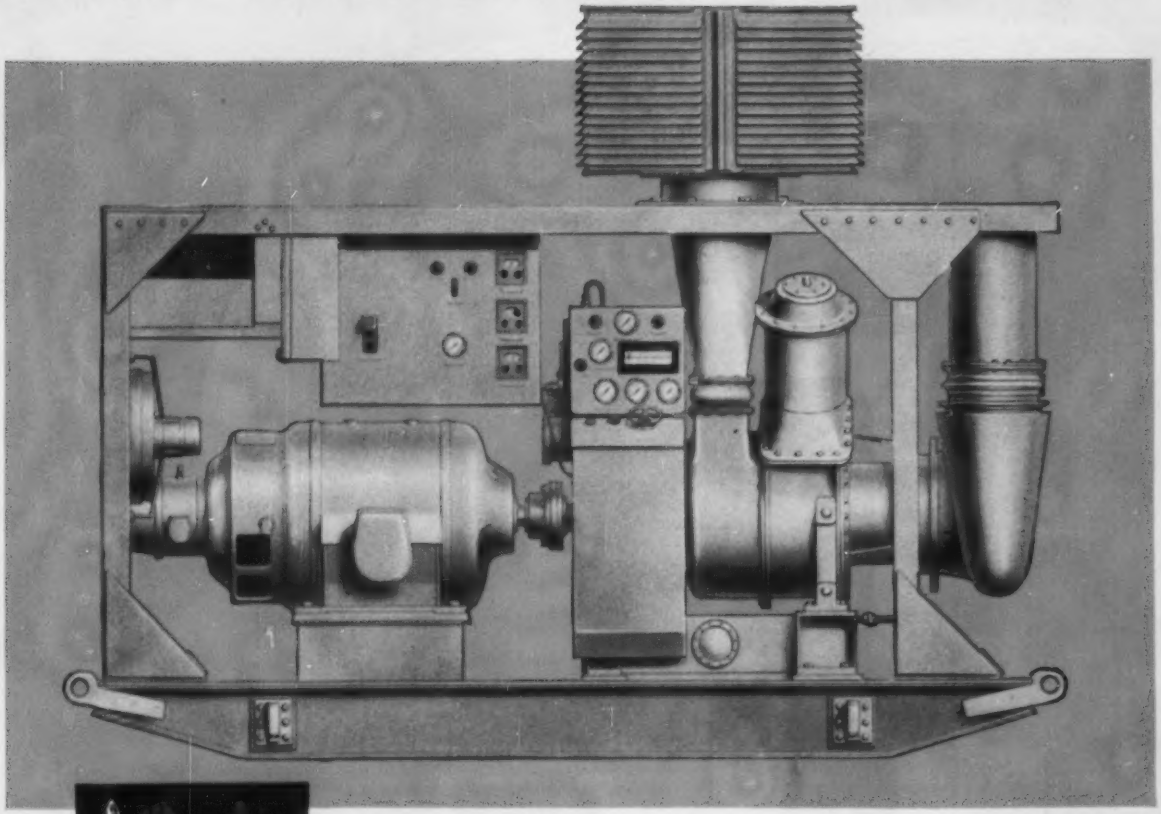
**508 Sandusky Street • Conneaut, Ohio**

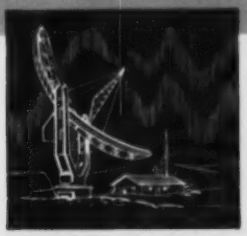
steam traps • air traps • float traps • vacuum or pumping traps
F and T traps • continuous blowdown valves • separators • engine stops

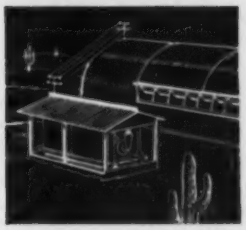


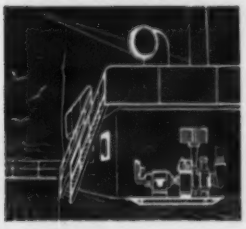
For more facts circle 400 on Reader Service card, p 103

# NEW Thompson-Ruston Model "TE" 300 kw Gas Turbine Generator Set









This gas turbine generator set is different. It is specifically designed for industrial portable or standby power requirements. This is not a delicate gas turbine—its experience has been on the ground, breathing the air and eating the dust of industrial atmospheres.

Compared to ultra-lightweight gas turbine generator sets of the aircraft type, the Model "TE" offers these important advantages:

**PROVEN RELIABILITY**—Simple, single-shaft, open-cycle design. The only turbine in its horsepower range designed and built for 50,000 hours service life.

**EASY MAINTENANCE**—Built to deliver a minimum of 5,000 hours between inspections, with all components easily accessible for routine maintenance.

**RUGGED CONSTRUCTION**—Engineered with low component stresses for heavy-duty service.

Complete specifications and performance data on this rugged new generator set are yours for the asking. Write on your company letterhead for additional descriptive data on the Thompson-Ruston Model "TE" Generator Set.

TRW

TAPCO GROUP

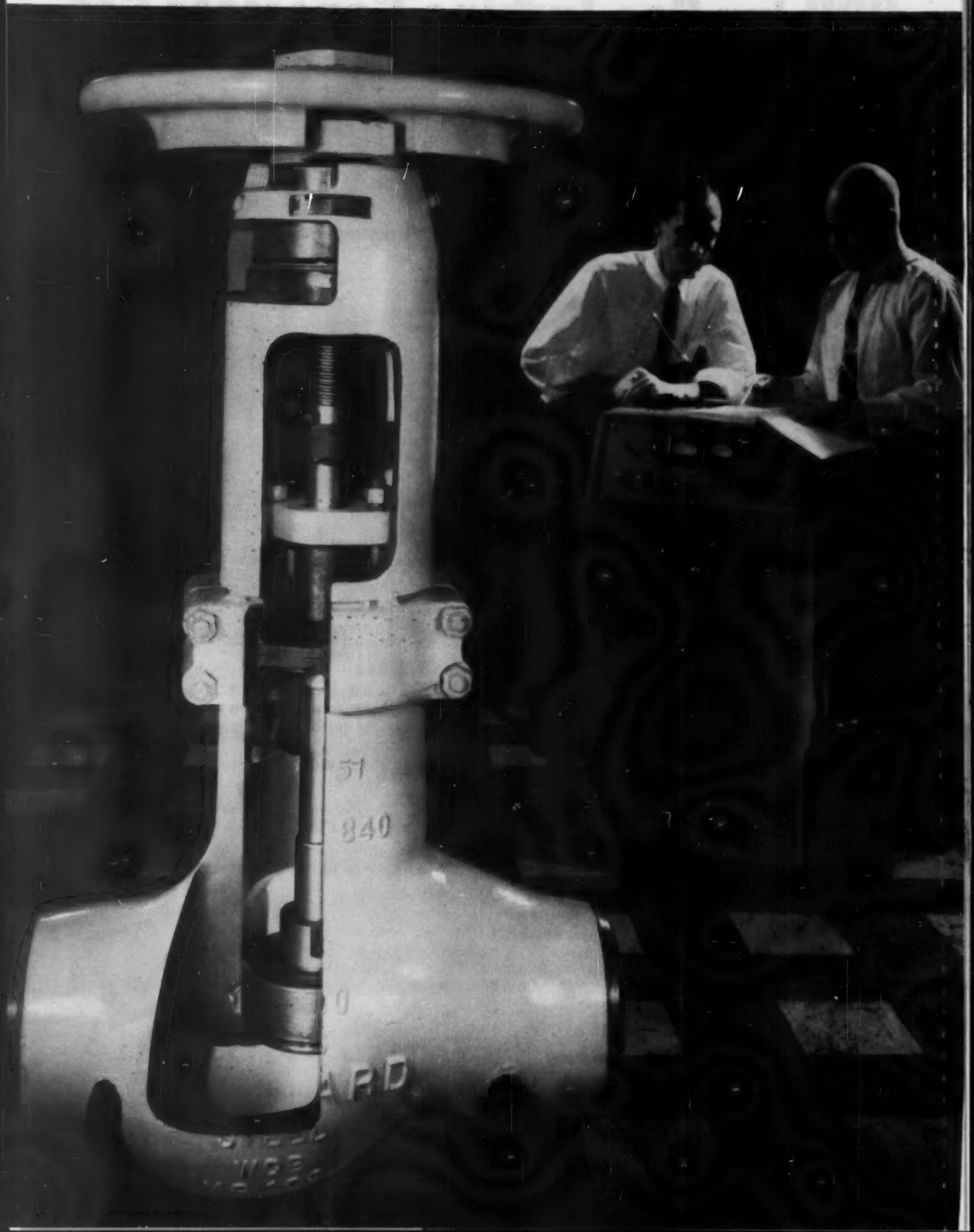
*Thompson Ramo Wooldridge Inc.*

Dept. P-660, Cleveland 17, Ohio

For more facts circle 222 on Reader Service card, p 103

For more facts circle 223 on Reader Service card, p 103

# The Story of Edward Research



# and the Pressure-Seal* Valve

The introduction, in 1945, of commercial steel valves with pressure-seal bonnet joint construction was a significant advance in the art of building large high-pressure steel valves. The new pressure-seal construction eliminated massive flanged bonnet joint connections and made it possible to seal the valves permanently at high temperature. These advantages were immediately apparent to users everywhere. But bonnet joint leakage problems developed on the new valves in service. And Edward engineers soon became convinced that the original 45° pressure-seal gasket design used by Edward and others required improvement. Here's the Edward pressure-seal redesign story:

**INITIAL TESTING**—Edward engineers began their studies on leak problems in 45° gasketed pressure-seal valves by determining under what conditions the valves were most likely to leak. It was discovered that when sealing areas were thoroughly degreased and tested with air, the pressure seal would leak at all pressures above 10 psi. In addition, minute imperfections in the sealing area of the valve body bore were preventing intimate gasket contact and contributing to leakage. Edward engineers found that a broader area of contact between gasket and bonnet and between gasket and body bore would also reduce leakage. Further investigation showed that a gasket plating material softer than the silver plating previously used would be helpful in achieving better contact in the sealing area.

To obtain more gasket sealing area, experiments were conducted on gaskets with angles from 45° down to 17°. Over a period of several months, tests were made with 25 different combinations of gasket and bonnet angles and various gasket plating materials. Assembled valves were tested for tightness with air pressures ranging from 10 psi to 2160 psi, and at temperatures up to 1000 F for extended periods. And tests on ease of valve disassembly (an important user consideration) were made with each gasket combination.

**TEST CONCLUSIONS**—At the end of their extensive testing program on the pressure-seal design, Edward engineers were able to draw these conclusions:

1. 45° gaskets, which showed no leak on water tests, leaked air at similar pressures.
2. No gasket of any design, either plain or with a plating of 100 Brinell or harder, would seal air when assembled unlubricated.
3. The best sealing under test resulted with a 25° gasket angle which was 1° more acute than the bonnet angle.
4. Gaskets of 25° angle actually tripled the sealing surface area.
5. A stainless inlay in the valve body bore sealing area substantially improved gasket-to-body contact and provided a corrosion-resistant surface.
6. Gaskets of 25° angle, plated properly with a malleable coating, gave perfect air or steam sealing at all temperatures, whether assembled dry or with a lubricant.

**NEW VALVE DESIGN**—As the result of their tests, Edward engineers designed the completely new pressure-seal valve with 25°-65° joint (see diagram below). This change in gasket angle, with an increase in sealing surface area, and the addition of a special corrosion-resistant malleable coating, brought an end to bonnet joint leakage in Edward pressure-seal valves. And, since 1953, thousands of Edward pressure-seal valves have been installed in a great variety of services *without a single case of failure reported to date.*

The story of Edward research and the pressure-seal valve is typical of the kind of research progress and product leadership you can expect from Edward Valves. Edward builds a complete line of forged and cast steel valves from ¼" to 18" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

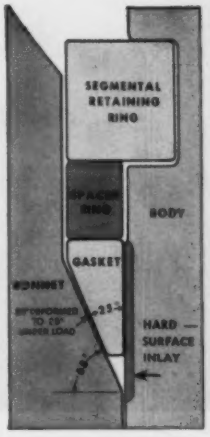
*Patented

EDWARD STEEL VALVES
another fine product by
ROCKWELL

**P. J. DUKES**, product development engineer, and D. MacGregor, works manager, are shown with helium leak detector used in testing pressure-seal valve joints.

**SPECIAL GAS-FIRED FURNACES** were used in temperature testing of new pressure-seal valve design. Furnaces heated valves up to 900 F for 24 hour periods. Pressure was maintained with hydro-pneumatic pumps.

**NEW 25° GASKET DESIGN**




For more facts circle 224 on Reader Service card, p 103

NEW!
by STOCK

# STOCK Equipment Company

## *announces*

## a New Volumetric Feeder for Short Center Installations

*Outstanding Features:*

- Endless belt
- Unobstructed 24" width of coal
- Large depth of coal to enable passage of occasional large pieces or frozen lumps of coal
- Curbs along edges of belt
- Variable speed drive utilizing magnetic slip clutch
- 50 psi explosion pressure housing for feeding pulverizers
- Belt change easily completed in 20 minutes
- Lights and bull's-eyes
- Poke hole next to inlet
- Stainless steel bottom liner
- Swing switch at outlet to stop feeder in event of coal stoppage in downspout to pulverizer
- Swing switch at inlet as required
- Models available for pulverizers and cyclones
- Centerline of inlet to centerline of outlet 2'-8", standard
- Intermediate centers 3'-8", 4'-8", 5'-8" 6'-8", 7'-8".

Long Center and Gravimetric Feeders are also available.

*For better feeding of coal to pulverizers and cyclones, write to*

# Equipment Company

725 HANNA BUILDING • CLEVELAND 15, OHIO

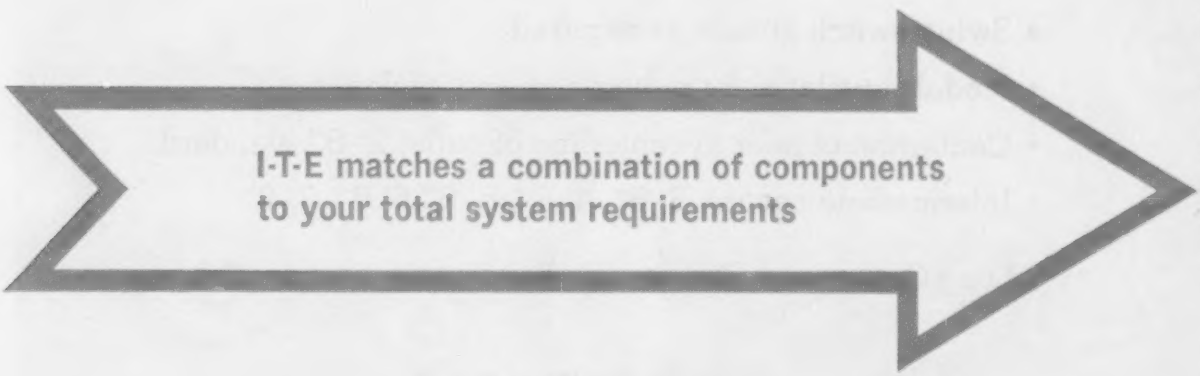


For more facts circle 225 on Reader Service card, p 103

# I-T-E's advanced fused interrupter switchgear with a Single Assembly Rating

**Slash Power Switching Costs with Assurance of Safe Fault Closing and Long Interrupting Life.** No longer do you need worry about individual component ratings for fused interrupter switchgear. With I-T-E's advanced Power Switching Centers you only concern yourself with specifying system conditions. I-T-E then *matches* a single assembly to your system requirements. You are assured of an integrated unit . . . switch, operating mechanism, fuse and housing . . . that will safely withstand the effects of *closing*, *carrying* and *interrupting* all values of current up to your system's specified short circuit capability (up to 600 amperes, continuous—and 500 mva short circuit capability).

Realize maximum economy where all the features of circuit breakers are not required. Prevent misapplication of protective equipment with I-T-E's Single Assembly Ratings. Get the complete story from your nearest I-T-E sales office or write I-T-E Circuit Breaker Company, Greensburg, Pa.

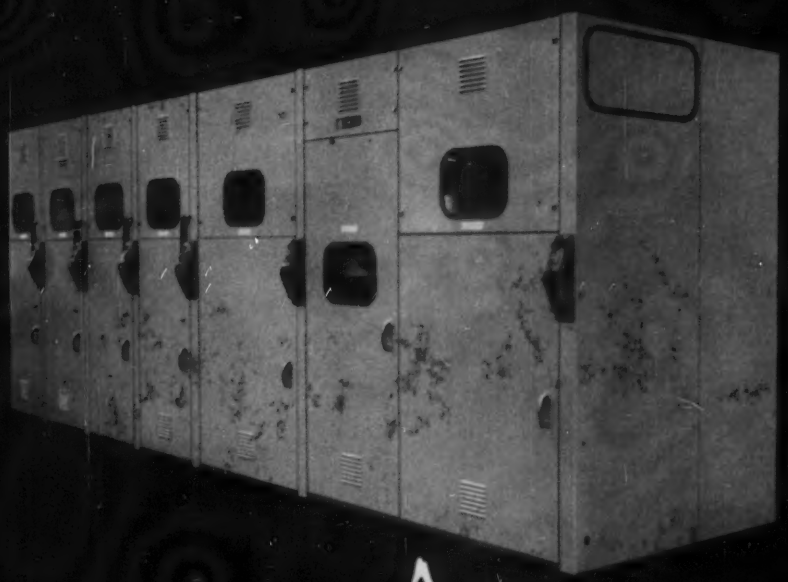



I-T-E CIRCUIT BREAKER COMPANY

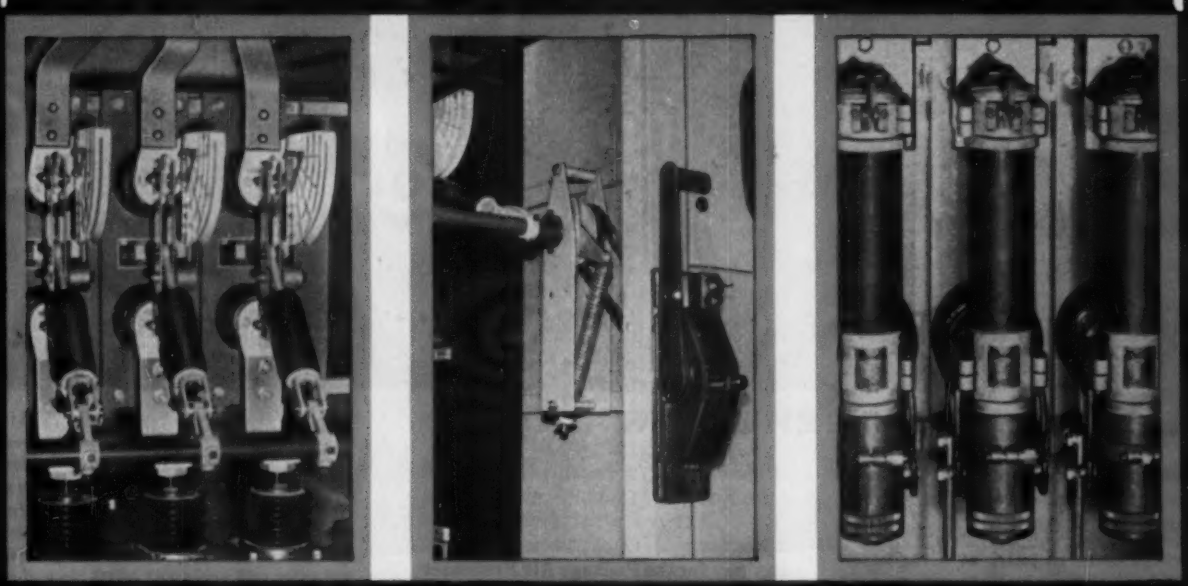


For more facts circle 226 on Reader Service card, p 103

Housing must withstand the effects of short circuits



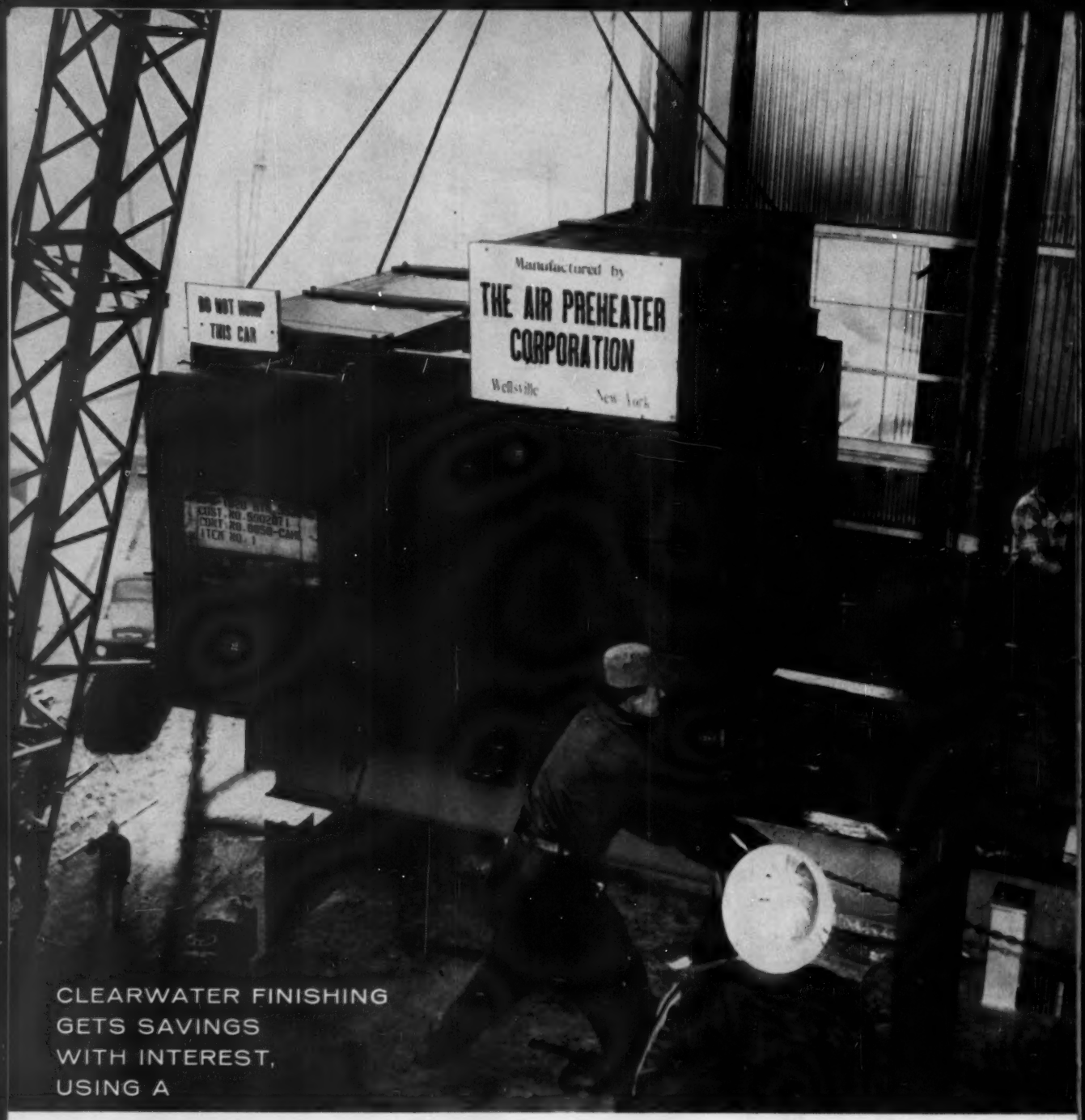
## The LOWEST RATED Component Determines Total Fault Protection!



Switch must pass continuous load current and momentarily withstand fault current

Under fault conditions, the mechanism must positively close the switch and/or hold it closed against short circuit current

Fuse must pass continuous load current and interrupt fault current




CLEARWATER FINISHING
GETS SAVINGS
WITH INTEREST,
USING A

# PACKAGE AIR PREHEATER

***Fuel savings alone pay for it in two years; installation costs cut by pre-assembly – –***

Savings come in pairs at Clearwater Finishing Co., with the installation of their new Package Air Preheater. This is why:

***1. Initial savings on installation.*** You can install a Package Air Preheater at a fraction of the expense required for conventional heat recovery equipment. The unit you see in the picture is a *complete* Package Air Preheater. To put it into service you simply lift it into place, make power and duct connections. It's that fast, that easy.

***2. Long term fuel savings*** . . . $17,000 a year off your fuel bill (more or less, depending on size of preheater and application). What you save on fuel can pay for the Package Air Preheater within two years.

Installation savings are achieved through standardized design, which permits complete shop assembly. Fuel savings are achieved through the efficient continuous regenerative heat recovery principle, which cuts your fuel bill 1% for each 45-50°F increase in preheated air temperature.

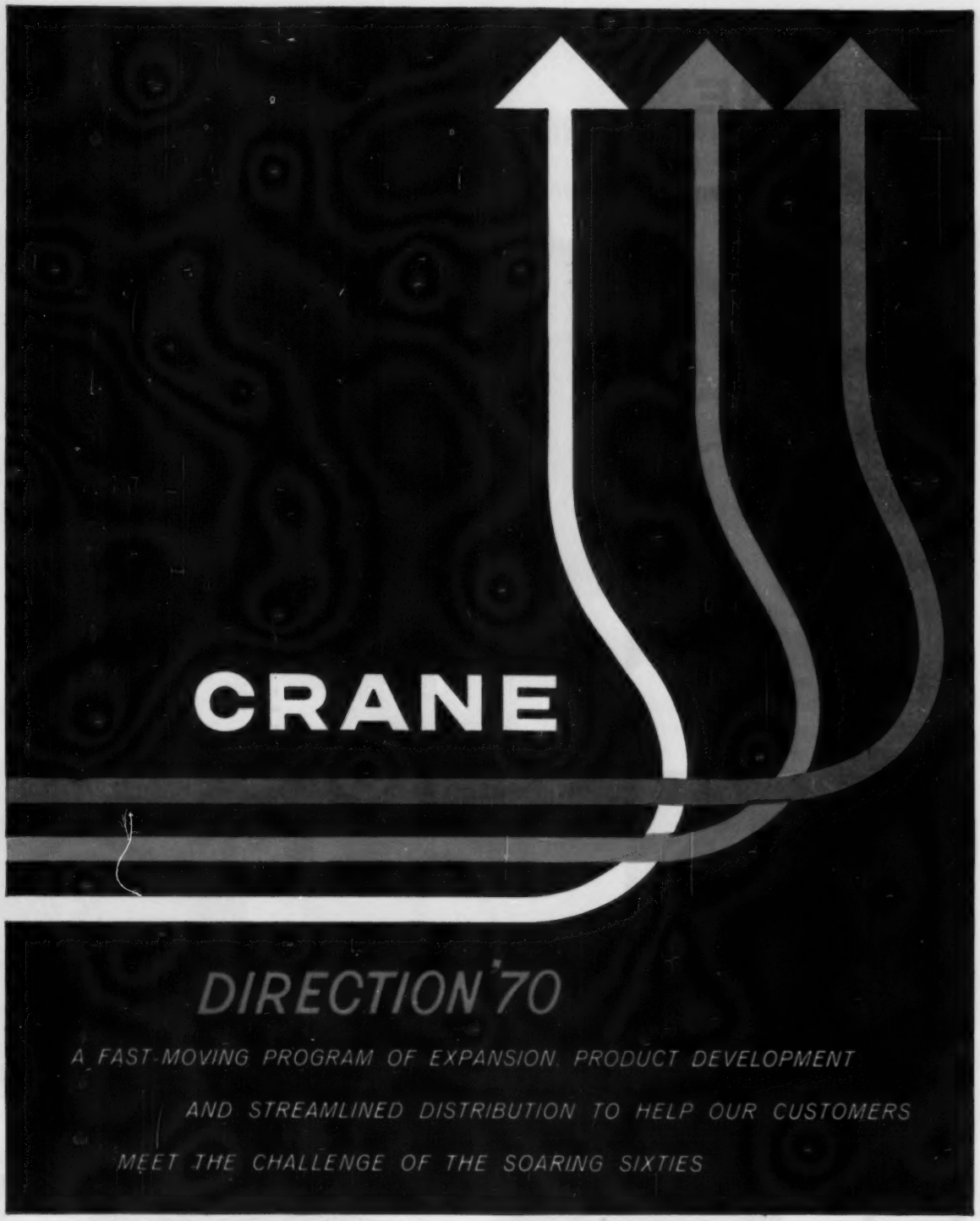
For application ideas, and facts and figures on the potential savings, write for free 14-page booklet.

*Completely pre-assembled Package Air Preheater is lifted into place at the new plant of Clearwater Finishing, (Division of United Merchants & Manufacturers, Inc.) at Clearwater, South Carolina. Installed at far less cost than a unit requiring on-site erection, this Package Air Preheater will serve a 83,000 lb/hr boiler. It measures approximately 8'x8'x6', and its 4900 sq ft of effective heating surface will recover 290°F from the stack gas.*

## THE AIR PREHEATER CORPORATION

*60 East 42nd Street, New York 17, N. Y.*
*Phone: MUrray Hill 2-8250*

**For more facts circle 227 on Reader Service card, p 103**


CRANE
DIRECTION '70
A FAST-MOVING PROGRAM OF EXPANSION, PRODUCT DEVELOPMENT
AND STREAMLINED DISTRIBUTION TO HELP OUR CUSTOMERS
MEET THE CHALLENGE OF THE SOARING SIXTIES

The Soaring Sixties have begun. This is the decade to be marked by accelerated industrial growth. By 1970, predictions are that . . .

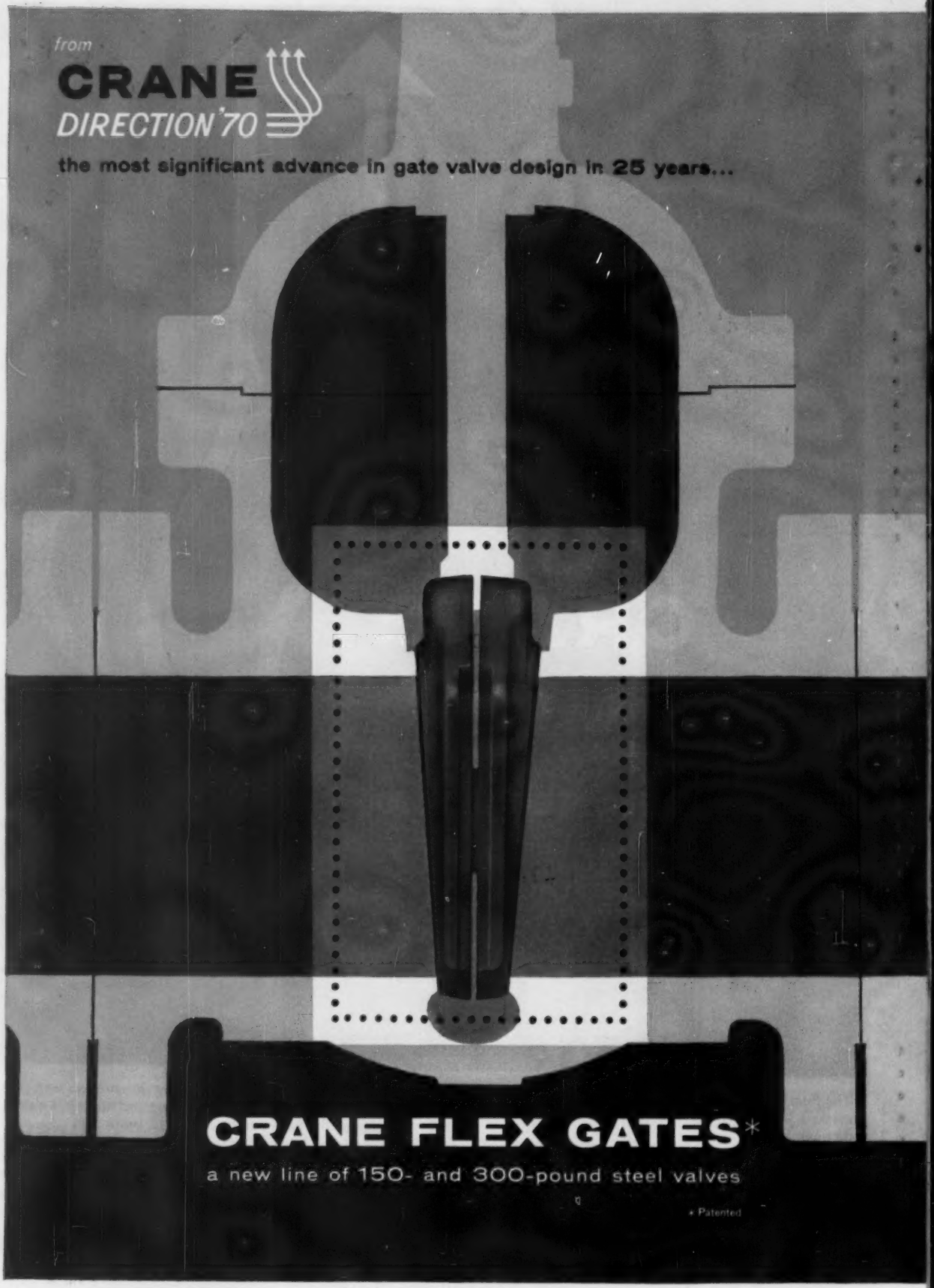
- machinery productio.. will double
- petroleum production will increase 4% to 5% each year
- chemicals are to double their present output at the current compound growth rate
- food processing will rise nearly 40%, paper and allied industries will expand about 60%

Total industrial production is estimated to rise some 60% in the next ten years. Looking at it another way, the prospective *increase* in manufacturing and mining is almost as large as the total output of just 12 years ago.

Crane announces Direction '70 . . . new products to help industry meet the challenge of the Soaring Sixties. These are products to improve quality control. These are products to increase production. These are products to help you control your costs. On the following pages is the first . . . the most significant Gate Valve improvement in 25 years. It's the first announcement of many you'll be seeing from Crane in Direction '70.

from
CRANE
DIRECTION '70

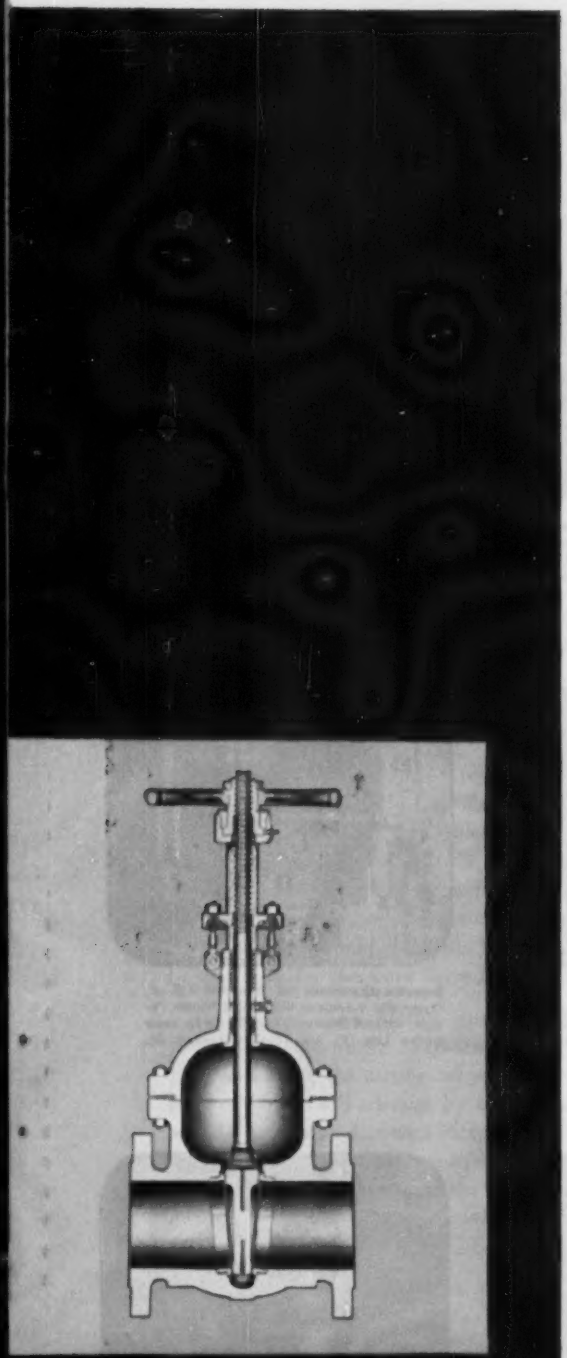
the most significant advance in gate valve design in 25 years...



CRANE FLEX GATES*

a new line of 150- and 300-pound steel valves

* Patented



Instead of being made with a solid disc, new Crane Flex Gates have separate disc faces, connected by the spool-like unit you see in the cross section. This joins the two seating faces, yet provides flexibility for the faces to seat tightly with independent action.

# FLEXIBILITY PROVIDES THESE BENEFITS

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates seat with less torque.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates unseat with less torque . . . will not stick closed even in high temperature service.

BECAUSE THEY'RE FLEXIBLE, minor deflection of seating faces due to pipe strains does not affect tightness of Crane Flex Gates.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates are tight on inlet seat and outlet seat over a wide range of pressures.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be used singly in some services where two conventional gate valves are frequently specified. You can save substantially on piping costs. And they have been exhaustively field tested.

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BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates will easily outperform any conventional solid wedge disc valve you now use. *And there's no increase in price.*

BECAUSE THEY'RE MADE BY CRANE, these new Flex Gates are completely dependable. You can use them with complete confidence on steam, water, gas, oil or oil vapor service. Stem and disc seating faces are Crane Exelloy. Shoulder-type body seat rings are Exelloy or Crane No. 49 Nickel Alloy. Sizes 12 inch and smaller; 150- and 300-pound pressure classes.

• • • • •

Ask your nearby Crane Distributor for full information on Flex Gates—and for data whenever you work with the products Crane makes. He has the newest in information *and* products. Crane Co., Industrial Products Group, 4100 South Kedzie Avenue, Chicago 32, Illinois.

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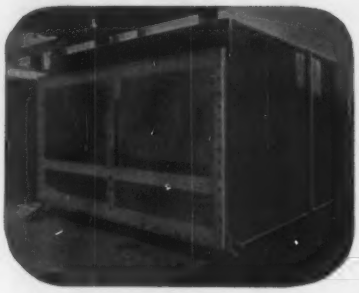
VALVES • ELECTRONIC CONTROLS • PIPING
PLUMBING • HEATING • AIR CONDITIONING



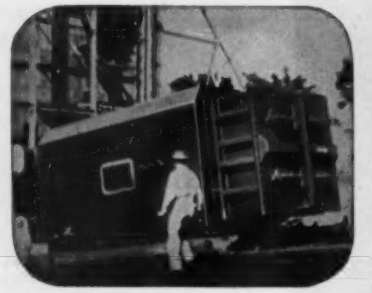
For more facts circle 228 on Reader Service card, p 103

and auxiliary equipment

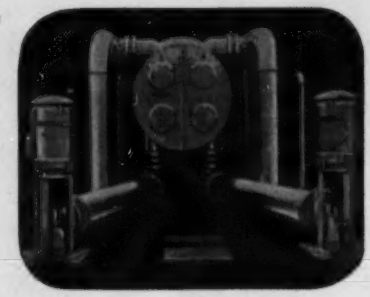
# HOW C.H. WHEELER CONDENSER DESIGN saves space...



**Head Room** problems are solved by compact condensers like this one. Turbine floor to basement floor, in this case, is only 20 ft. The Unit has 65,000 square feet of condensing surface.



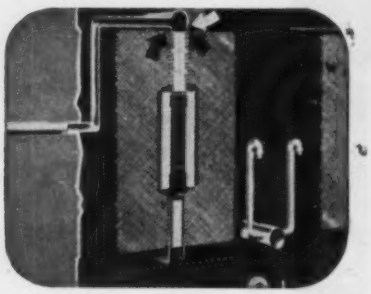
**Rectangular Cross Section** makes C.H. Wheeler Condensers adaptable to nearly any space or condenser arrangement because the length, width and height of any Wheeler Unit can be varied almost at will.



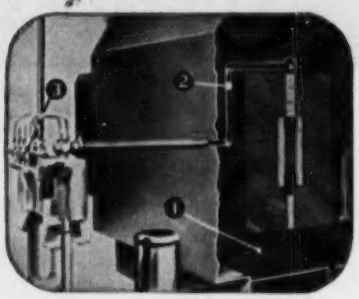
**But Wheeler Doesn't** limit itself to rectangular design. A round cross section worked out better here, for example, at the first planned gas-steam turbine station ever designed and built in United States.

## improves power generating efficiencies...

**Triple Lane tube layout,** another design feature, provides 3 pathways for steam travel, utilizes maximum cooling surface and produces higher condenser vacuums for power generating stations.

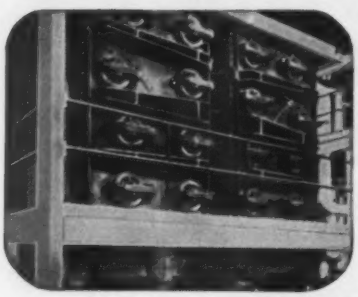


**Location of air-vapor takeoff** speeds steam travel and allows steam to penetrate to the peripheries of all tubes. It thus improves condenser efficiencies and overall power station operation as well.

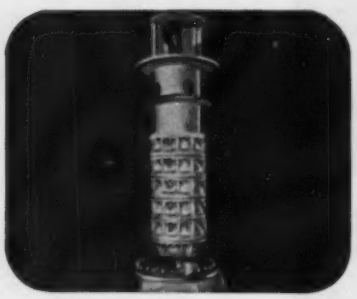



**Deaeration of condensate** not to exceed 0.01 cc. oxygen/liter is available with special Wheeler designs. Note the Deaerating Bars (1), the Air-Vapor Suction Line (2), and Tubejet® Ejectors (3).

## and reduces maintenance



**Patented Reverse Flow** permits flushing tubes and sheets without shutting down Unit, during full load with either or both circulating pumps operating. No additional circulating water inlet or discharge piping necessary with C.H. Wheeler's Reverse Flow.



**"Pull-Out" Condensate Pumps** simplify maintenance because entire pumping element, including all rotating parts, can be removed without disturbing either the pump barrel or the piping connections.

**C. H. Wheeler Circulating Pumps,** like Condensate Pumps, are easy to inspect and maintain because of "Pull-Out" design. In addition, shafts are heat treated alloy steel and impellers are statically and dynamically balanced for trouble-free operation.

C. H. Wheeler has been designing and building condensers since 1903; has developed such features as Dual Bank Design and Reverse Flow.

# C. H. WHEELER MFG. CO.

19TH & LEHIGH AVENUE
Philadelphia 32, Pennsylvania

*Whenever you see the name C. H. Wheeler on a product, you know it's a quality product*

**Steam Condensers • Steam Jet Vacuum Equipment • Centrifugal, Axial and Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products**




For more facts circle 229 on Reader Service card, p 103

LOUIS N ROWLEY, EDITOR • JUNE 1960 • ESTABLISHED 1882 **Power**

# Manpower in the '60's

Our manpower potential is great enough to increase U.S. production of goods and services by 50% from 1960 to 1970. Even with an expanding population to share this greater output, we can have a 25% increase in our standard of living.

The Department of Labor report that presents these encouraging conclusions also points up some challenging aspects of the growth and change in the U.S. work force during the ten years ahead. In that period, the total work force will increase by nearly 20%, faster than the general rate of growth of our population. This will be the largest 10-year gain for the work force in history.

The biggest share of this gain will come from *young* workers—under 25 years of age. Between 1960 and 1970, the number of such newcomers to the work force will advance by 46%. The number of older workers—45 years of age and older—will increase by 20%. A considerably smaller gain, 12%, will be registered by the 25-34 age group, and there will be an actual *shrinkage* of 1% in the 35-44 age group.

What do these figures mean to us as designers and managers of industry's energy systems? Clearly, we must be prepared for an influx of inexperienced workers. If these newcomers to the work force are to be utilized effectively—as they must be if we are to move forward—we will need to design our systems with this in mind.

But even more importantly, we must plan for enlarged—and improved—training activities. Not only must we be prepared to cope with more personnel needing training to assume operating and maintenance responsibilities, but we must insure the kind of training that will gear generally younger men for technical assignments that will be more demanding as our energy systems become more sophisticated.

If your company now has a sound training program, the influx of inexperienced workers will present no new problems, merely an intensification of effort. But if you don't do a real training job and count on hiring experienced men, you will face some changes. Experienced men will be vastly harder to come by and successful operation will probably demand training programs.

A different sort of challenge is presented by the shrinkage in the 35-44-year age group. This is the group from which managers and executives normally come. One immediate effect of the smaller number of men in this group will be the need for better means of finding and developing managerial ability. This has always been important, but it will have even greater emphasis in the years ahead.

Sound procedures for identifying and developing management potential will pay off, not only in insuring maximum utilization of the 35-44 age group, but in spotting "comers" among younger men.

Only by meeting these and similar manpower challenges can we discharge our responsibilities as engineering managers. And only if all such responsibilities are discharged can we look forward to the growth of the national economy—and of personal prosperity—that is the potential of the industrial expansion envisioned for the '60's.

# NOW! Fuses that...

## *Safely interrupt fault currents up to 200,000 amperes...*

## *Limit fault current to very low values*

## *Hold 500% load for minimum of ten seconds*

**Buss Low Peak fuses can completely revolutionize the protection of the entire electrical system.**

Protect Mains, Feeders, Branch Circuits, Motors, Controllers, Switches—no matter whether the fault current is 1,000 amperes, 25,000, 100,000—or as high as 200,000 amperes.

Reduce stresses and prevent damage to Panel-boards, Switches, Motor Controllers—other circuit components—because let-thru fault currents are limited to exceptionally low values.

Prevent work stoppages, lights out, waste of time and money—because long time-lag keeps them from opening needlessly on motor starting currents or other harmless overloads.

Permit increasing interrupting capacity and current limitation on present system at minimum cost.

***Before designing a new installation—***
***or modernizing old installations—***

**GET ALL THE FACTS**

Knowledge without action is of little value—but ACTION NOW may save you money—increase operating efficiency and reduce electrical hazards to a minimum.

BUSS LOW-PEAK fuses fit standard Switches and Panel-boards and are available in N.E.C. sizes from 15 to 600 amperes in both 250 and 600 volt ranges.

Write for BUSS LOW-PEAK Bulletin Now . . . or use coupon.

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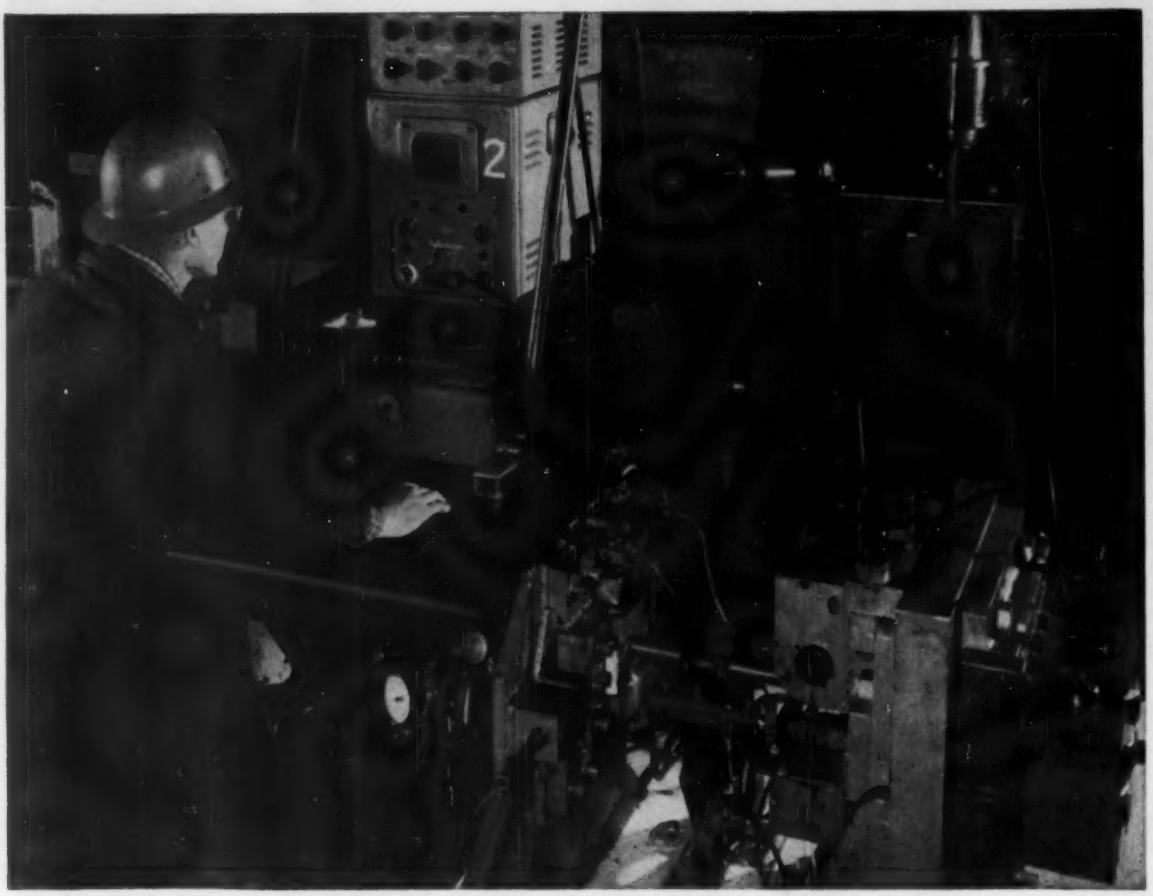

# How to inspect electric welded tubing with ultrasonic sound waves

National Tube tests all USS National Electric-Resistance Welded Pressure Tubing with ultrasonic sound waves. As the tubing slides directly over a ground quartz crystal, electrical pulses are focused on the weld area. The crystal changes these pulses into ultrasonic vibrations which bounce off the the weld and reflect its strength or weakness. The vibrations are speared by the crystal, converted back into electrical energy, and floated across an oscilloscope screen.

If a bad weld is reflected, the electrical current dances wildly on the screen and triggers an alarm system. The crooked pattern is pen-recorded on a graph, a frog-voiced horn croaks loudly, and the tubing is squirted with black paint to mark the defect.

In case the ultrasonic unit breaks down, a red-faced dome light automatically flashes, revolves and winks at the weld inspector. This blushing signal tells him that the unit needs to be checked. It's added insurance that every length of pressure tubing is completely tested before it leaves the plant.

Our inspection techniques are rigid. But they help us develop a high quality product for use in applications such as boilers, heat exchangers, condensers, superheaters, economizers and other types of heat transfer equipment.

USS National Electric Welded Pressure Tubing is available in sizes ½" O.D. to 5½" O.D. inclusive, in walls from .035" to .250", and in lengths up to 44 feet. Consider USS National Electric Welded Tubing for your next installation. It's stocked by National Tube Distributors all over the country. Our trained Mill Service Force is also available for field consultation. Write National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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# Piping

## Materials
## Supports
## Expansion joints
## Fittings
## Fluid losses
## ASA standards

By T W EDWARDS
*Assistant Editor*

In the broad field of energy-systems engineering, pipes are arteries interconnecting machines. Without piping, today's energy systems—steam, compressed gas, air conditioning, refrigeration, liquid handling—could not exist.

Piping and piping standards have been with us a long time. Pipe's lengthy history runs back 4000 years to ancient Crete, where tile pipe was used for water distribution. In 1820 the first standards appeared for cast-iron pipe up to ten in.; two years later Britain's Robert Briggs worked out a pipe-thread standard later adopted in America.

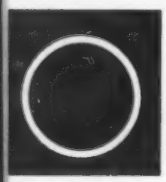
About the turn of the century 95% of all pipe installed was cast iron. Since then piping technology has burgeoned into an almost infinite variety of materials, fittings and supports. Example: plastic pipe is growing at a spectacular rate, solving many of today's special problems and stepping in for more traditional piping materials. Alloy-steel pipe in high-pressure-temperature applications permits thermal efficiencies not dreamed possible some years ago. And the end is not in sight. Piping technology must continue growing at this rate to keep ahead of industrial progress.

This report is aimed primarily at those energy-system engineers who must maintain close contact with the piping field yet who do not design piping systems on a full-time basis. These men have found that much required information is scattered and often goes well beyond their immediate needs. But full-time piping designers will also find this report handy, for reference and quick review. In bringing together the essential information needed to design a wide variety of piping systems, it serves as a practical guide for checking existing systems as well as laying out entirely new schemes. Space does not permit data on valves; they'll be the subject of a later report.

On the following 16 pages you will find up-to-date information on piping materials, advantages and limitations of each, what fittings and supports are being used, fundamentals of fluid-loss calculations. If your design work goes beyond the tabulated data, or more detailed information is needed to complete the system, refer to ASA Standards listed on last page.

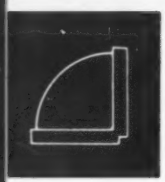
a **Power** special report
June 1960

# Three basic factors in piping-system design:



## PIPING MATERIALS

In addition to the more-common metallic and nonmetallic piping materials, new alloys and wholly new basic compositions are now available to meet increasingly severe operating conditions. Plastics are a case in point. Now commercially available, these man-made materials seemed to have little prospect some years back. Also, rising temperatures and pressures help spotlight the consideration you must give corrosion when selecting piping materials—and several new corrosion problems face today's piping designer. National and local codes establish pressure and temperature limits for combined safety of men and machines. Maximum stress limits for very-high-temperature alloy-steel applications are now set by creep characteristics rather than by tensile or yield points to get better design values.

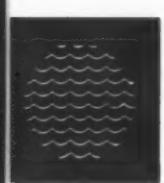


## SUPPORTS AND FITTINGS

It is generally accepted that fittings must be consistent with pipe material used throughout the system. In some areas there is a decrease in field welding and number of fittings because of increased adoption of shop-fabricated pipe sections, made possible by modern techniques in hot and cold pipe bending. Yet, as in all cases of prefabrication, an engineering study of the true costs is necessary before a sound decision can be made.

Hangers to support long runs of pipe in buildings are generally attached to either wall or ceiling. In underground tunnels, piping is usually supported from the floor. In addition to the many rigid hangers available, constant-support hangers, having nearly constant weight-carrying capability through considerable travel, are seeing wide use. This feature is especially important where thermal changes in pipe-system geometry occur and end reactions on connected equipment must be severely limited. A hanger now available actually positions the piping mechanically in response to signals from a remote but related point in the system.

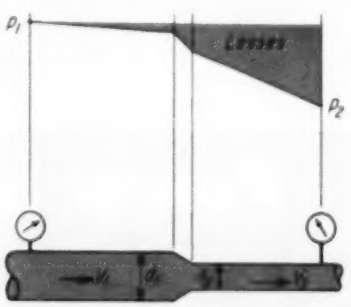
Changes in piping-system length, due to temperature difference, can be compensated for in other ways, too. Simple expansion joints with flexible bellows or slip joints are seeing application for low and intermediate pressures. Geometry or expansion loops handle very-high pressures.



## FLUID LOSSES

Real starting point in system design comes in determining fluid losses caused by hydraulic friction. It is these losses that set pipe size. To determine losses accurately, all characteristics of the fluid handled must be known. The final pipe size is one giving an economic balance between installed cost of the piping system and capitalized annual pumping charges. Balance comes at the point of least total annual cost. Of course there are special cases where this doesn't hold true: in pumping slurries, for example, certain minimum velocities must be maintained to prevent settling: this is the primary consideration regardless of hydraulic optimums.

**Hydraulic gradients** are graphical representations of fluid losses in piping systems. In this short section flow is constant; pressure $p_1$ drops off slowly in the large section of pipe since velocity $V_1$ is low. After the reducer, however, velocity $V_2$ increases (since flow is unchanged but diameter is reduced), so pressure drop increases. Fluid losses (function of $V$) are therefore higher for smaller-diameter pipe.



# STEEL

**Far from being on a plateau, steel-piping technology has surged ahead along with other advances in energy systems. Not too many years back, turbine throttle pressures of 900 psi, temperatures of 900 F were considered high for central-station power plants. Today there is a 5000-psi 1200-F unit in operation, fed through modern steel pipe. Corrosion in high-temperature-pressure applications is another area currently getting a hard look.**

Welding, casting, extruding are the three techniques used today in making steel pipe. Welded pipe (either spiral or straight welded) is less costly than the seamless product of extrusion but can be used only for relatively low-pressure applications. Cast-steel pipe is not generally approved by the ASME Power Code. However, approval of cast-steel pipe is currently being reconsidered in light of new centrifugal-casting techniques. Seamless-steel pipe is by far the most widely used in energy systems today.

**Forged-steel pipe,** a "special" type, either is turned and bored from a solid-steel billet or is an extrusion heavy enough to radically alter the steel's grain structure. Although more expensive, bored and turned forged-steel pipe is available in longer lengths. This latter feature is particularly useful where high cost of field welding is a factor. Another member of the forged-steel family, and somewhat less expensive, is the extruded or seamless wrought pipe which is unidirectional in grain structure.

**Properties** of selected steel pipe, recommended stress limits for h-t service, relative costs and standard-schedule pipe dimensions are listed in tabular form on the next two pages. Note following in connection with the tables:

ASTM-106 carbon-steel piping is used only in the non-creep temperature range (up to about 800 F). Usually type A is for smaller pipe sizes, types B and C for the larger. In the ASTM-A335 group, type P22 is the highest chrome alloy normally required for steam service where corrosion due to the *steam alone* must be considered. Choice between P22 and one of the lower chrome-alloy steels is one of simple economics arrived at by equating first cost and wall thickness based on allowable stress.

**Corrosion** caused by *impurities* in the steam demands higher chrome alloys. ASTM-312 and -376 austenitic stainless steels are especially well suited for very-high pressure-temperature range. Once again, choice is one of straight economics. Current studies may throw additional light on this acute problem of steel-pipe corrosion.

To date, mechanics of stress corrosion by chlorides in the presence of oxygen are fairly well understood. However caustic stress corrosion is a different matter requiring much more study and research in field and laboratory.

In addition to the typical steel-pipe materials listed in the following table, there are others available to suit special needs. For example, several austenitic stainless steels have been specifically designed for nuclear use.

**Allowable stress values** shown in the table are based on yield point or tensile strength for all materials up to about 800 F. At higher temperatures creep characteristics are used to set allowable stresses. In commercial practice, stresses are set to produce a maximum creep of 1% in 100,000 hr. Several stress values are shown in *italics;* these are for reference only, are not normally used as design values.

**Current standard dimensions** for "schedule" steel pipe are listed in the bottom table on following pages. Three sizing schemes in current use are shown: (1) ASA steel-pipe schedules (2) ASA steel-pipe nominal-wall-thickness designations (S—standard, XS—extra strong, XXS—double extra strong) and (3) lightweight stainless-steel pipe schedules. ASA steel-pipe schedules are slowly replacing the older nominal-wall-thickness designations. The former are more flexible, permit more standard sizes and are less cumbersome to use. Note that in the lightweight stainless-steel schedules 5S is not as yet an approved standard. Steel tubing is merely an unscheduled size. So if you need a nonstandard wall thickness you must order tubing; make your specs complete.

## Pipe testing, Code field welding check system maintenance costs

In addition to usual hydrostatic and surface tests, a growing number of pipe manufacturers are turning to ultrasonic testing as an effective means of detecting internal flaws in high-temperature high-pressure piping.

Field-erection costs are minimized by extensive shop fabrication of complex piping systems. New techniques for hot and cold bending cut field welding and number of weld-end and socket-weld fittings needed—reducing costs still more. Proper field welding, especially of high-alloy steel pipe, calls for extensive pre and post heat treatment. Skilled welders, qualified in accord with the ASME Boiler Code, are a must if you want to be sure

of strict Code welding. X-ray or similar examination of field welds is one more guarantee of soundness and trouble-free piping-system life.

Careful material selection, pipe-schedule determination and attention to all the details of fabrication are the heart of piping-system design. So now let's see exactly how to figure the right pipe schedule for your job.

## How to figure steel-pipe schedule

Use formula below to figure pipe thickness needed, material and nominal pipe size for a particular job.

$$t_m = \frac{PD}{2S + 2yP} + C \qquad \text{where:}$$

$t_m$ = minimum wall thickness, in. If solving for nominal thickness add 12½% to cover mill tolerance

$P$ = maximum internal pressure, psig, at operating temperature

$D$ = outside pipe diameter, in.

$S$ = allowable stress at operating temperature, psi, from table at right

$C$ = allowance for structural stability only; make additional allowance for corrosion

Threaded pipe (¾ in. and smaller) ——— 0.065
Threaded pipe (1 in. and larger) – depth of thread
Grooved pipe ——— depth of groove
Plain-end pipe (3½ in. and smaller) ——— 0.065
Plain-end pipe (4 in. and larger) ——— 0.000

$y$ = metal and temperature coefficient:

| *Steel type* | *Temperature, deg F* | | | | | |
|---|---|---|---|---|---|---|
| | under 900 | 950 | 1000 | 1050 | 1100 | above 1150 |
| Ferritic | 0.4 | 0.5 | 0.7 | 0.7 | 0.7 | 0.7 |
| Austenitic | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.7 |

Now check table at right and pick schedule of pipe having next-larger wall thickness. Recheck pressure and temperature rating using actual pipe dimensions. Using actual pipe *ID*, recheck hydraulic losses.

## Figure pipe weight per ft of length

First get inside diameter in inches:

$$ID = OD - 2t \qquad \text{where:}$$

$ID$ = inside diameter of pipe, in.
$OD$ = outside diameter from table, in.
$t$ = pipe-wall thickness from table, in.

Then:

$$\text{Wt per ft of length} = 0.85\pi\ (OD^2 - ID^2)$$

Example: For 8-in. XS pipe (sch 80) actual $OD = 8.625$ in.
Then $ID = 8.625 - 2 \times 0.5$ or 7.625 in.
Wt per ft $= 0.85\pi\ (8.625^2 - 7.625^2)$
or 43.39 lb per ft

# When designing a steel-pipe system

## Pipe material hinges on operating conditions

| Composition | Carbon-steel grades ASTM Spec No. A106 | | |
|---|---|---|---|
| | A | B | C |
| Carbon | 0.25 max | 0.030 max | 0.35 max |
| Manganese | 0.27–0.93 | 0.29–1.06 | 0.29–1.06 |
| Sulfur | 0.058 max | 0.058 max | 0.058 max |
| Phosphorus | 0.048 max | 0.048 max | 0.048 max |
| Silicon | 0.010 min | 0.010 min | 0.10 min |
| Chromium | ——— | ——— | ——— |
| Molybdenum | ——— | ——— | ——— |
| Nickel | ——— | ——— | ——— |
| Columbium | ——— | ——— | ——— |

## Find allowable psi stress at actual temperature

| | | | |
|---|---|---|---|
| 100F | —— | —— | —— |
| 200 | —— | —— | —— |
| 400 | 12000 | 15000 | 17500 |
| 600 | 12000 | 15000 | 17500 |
| 700 | 11650 | 14350 | 16600 |
| 800 | 9000 | 10800 | 12000 |
| 900 | 5000 | 5000 | —— |
| 1000 | 1500 | 1500 | —— |
| 1050 | —— | —— | —— |
| 1100 | —— | —— | —— |
| 1150 | —— | —— | —— |
| 1200 | —— | —— | —— |
| 1250 | —— | —— | —— |
| 1300 | —— | —— | —— |
| 1350 | —— | —— | —— |
| 1400 | —— | —— | —— |
| 1450 | —— | —— | —— |
| 1500 | —— | —— | —— |

## Check relative cost—carbon steel is base

| | | | |
|---|---|---|---|
| | $1.00 | $1.00 | $1.00 |

## Next step: choose the pipe schedule

| Nominal pipe size, in. | ⅛ | ¼ | ⅜ | ½ | ¾ | 1 |
|---|---|---|---|---|---|---|
| Outside diameter, in. | 0.405 | 0.540 | 0.675 | 0.840 | 1.050 | 1.315 |

## Steel-pipe schedules—thickness in in.

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | —— | —— | —— | —— | —— | —— |
| 20 | —— | —— | —— | —— | —— | —— |
| 30 | —— | —— | —— | —— | —— | —— |
| 40 | 0.068 | 0.088 | 0.091 | 0.109 | 0.113 | 0.133 |
| 60 | —— | —— | —— | —— | —— | —— |
| 80 | 0.095 | 0.119 | 0.126 | 0.147 | 0.154 | 0.179 |
| 100 | —— | —— | —— | —— | —— | —— |
| 120 | —— | —— | —— | —— | —— | —— |
| 140 | —— | —— | —— | —— | —— | —— |
| 160 | —— | —— | —— | 0.187 | 0.218 | 0.250 |

## Wall-thickness designation—in.

| | | | | | | |
|---|---|---|---|---|---|---|
| S | 0.068 | 0.088 | 0.091 | 0.109 | 0.113 | 0.133 |
| XS | 0.095 | 0.119 | 0.126 | 0.147 | 0.154 | 0.179 |
| XXS | —— | —— | —— | 0.294 | 0.308 | 0.358 |

## Stainless-steel schedules—thickness in in.

| | | | | | | |
|---|---|---|---|---|---|---|
| 5S | —— | —— | —— | —— | 0.065 | 0.065 |
| 10S | 0.049 | 0.065 | 0.065 | 0.083 | 0.083 | 0.109 |
| 40S | 0.068 | 0.088 | 0.091 | 0.109 | 0.113 | 0.133 |
| 80S | 0.095 | 0.119 | 0.126 | 0.147 | 0.154 | 0.179 |

## first select material, then check stress and cost, figure wall thickness

| | Chrome-steel grades—ASTM Spec No. A335 | | | | | | Austenitic-steel grades ASTM Spec No. A312 and A376 | | |
|---|---|---|---|---|---|---|---|---|---|
| | P12 | P11 | P22 | P21 | P5 | P9 | TP 304 | TP 347 | TP 316 |
| | 0.15 max | 0.15 max | 0.15 max | 0.15 max | 0.15 max | 0.15 max | 0.08 max | 0.08 max | 0.08 max |
| | 0.30–0.61 | 0.30–0.60 | 0.30–0.60 | 0.30–0.60 | 0.30–0.60 | 0.30–0.60 | 2.00 max | 2.00 max | 2.00 max |
| | 0.045 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max |
| | 0.045 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max | 0.030 max |
| | 0.50 max | 0.50–1.00 | 0.50 max | 0.50 max | 0.50 max | 0.25–1.00 | 0.75 max | 1.00 max | 0.75 max |
| | 0.80–1.25 | 1.00–1.50 | 1.90–2.60 | 2.65–3.35 | 4.0–6.0 | 8.0–10.0 | 18.0–20.0 | 17.0–20.0 | 16.0–18.0 |
| | 0.44–0.65 | 0.44–0.65 | 0.87–1.13 | 0.80–1.06 | 0.45–0.65 | 0.90–1.10 | ——— | ——— | 2.0–3.0 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 8.0–11.0 | 9.0–12.0 | 11.0–14.0 |
| | ——— | ——— | ——— | ——— | ——— | ——— | ——— | (A) | ——— |
| | ——— | ——— | ——— | ——— | ——— | ——— | 18750 | 18750 | 18750 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 16650 | 18750 | 18750 |
| | 15000 | 15000 | 15000 | 15000 | 15000 | 15000 | 13650 | 15800 | 17500 |
| | 15000 | 15000 | 15000 | 15000 | 14000 | 14000 | 11600 | 14900 | 17100 |
| | 15000 | 15000 | 15000 | 14800 | 13400 | 13400 | 10800 | 14800 | 17000 |
| | 14750 | 15000 | 15000 | 13900 | 12900 | 12800 | 10000 | 14550 | 16750 |
| | 13100 | 13100 | 13100 | 12000 | 11500 | 12000 | 9400 | 14100 | 16000 |
| | 7500 | 7800 | 7800 | 7000 | 7300 | 8500 | 8800 | 13500 | 14000 |
| | 5000 | 5500 | 5800 | 5500 | 5200 | 5500 | 8500 | 13100 | 12200 |
| | 2800 | 4000 | 4200 | 4000 | 3300 | 3300 | 7500 | 10300 | 10400 |
| | 1550 | 2500 | 3000 | 2700 | 2200 | 2200 | 5750 | 7600 | 8500 |
| | 1000 | 1200 | 2000 | 1500 | 1500 | 1500 | 4500 | 5000 | 6800 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 3250 | 3300 | 5300 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 2450 | 2200 | 4000 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 1800 | 1500 | 2700 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 1400 | 1200 | 2000 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 1000 | 900 | 1500 |
| | ——— | ——— | ——— | ——— | ——— | ——— | 750 | 750 | 1000 |
| | $1.86 | $1.95 | $2.44 | $2.49 | $2.76 | $3.98 | $8.76 | $12.81 | $14.06 |

Stress values shown in *italics* are permissible but not in current practice. Allowable-stress values below 800 F are based on yield or tensile stresses. Allowable-stress values above 800 F are based on 1% creep in 100,000 hr.
(A) Combined columbium and tantalum content shall not be less than ten times the carbon and not more than 1%

## best suited for the size and thickness you've already determined

| 1¼ | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.660 | 1.900 | 2.375 | 2.875 | 3.500 | 4.000 | 4.500 | 5.563 | 6.625 | 8.625 | 10.750 | 12.750 | 14.000 | 16.000 |
| ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | 0.250 | 0.250 |
| ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | 0.250 | 0.250 | 0.250 | 0.312 | 0.312 |
| ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | 0.277 | 0.307 | 0.330 | 0.375 | 0.375 |
| 0.140 | 0.145 | 0.154 | 0.203 | 0.216 | 0.226 | 0.237 | 0.258 | 0.280 | 0.322 | 0.365 | 0.406 | 0.438 | 0.500 |
| ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | 0.406 | 0.500 | 0.562 | 0.593 | 0.656 |
| 0.191 | 0.200 | 0.218 | 0.276 | 0.300 | 0.318 | 0.337 | 0.375 | 0.432 | 0.500 | 0.593 | 0.687 | 0.750 | 0.843 |
| ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | 0.593 | 0.718 | 0.843 | 0.937 | 1.031 |
| ——— | ——— | ——— | ——— | ——— | ——— | 0.438 | 0.500 | 0.562 | 0.718 | 0.843 | 1.000 | 1.093 | 1.218 |
| ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | ——— | 0.812 | 1.000 | 1.125 | 1.250 | 1.438 |
| 0.250 | 0.281 | 0.343 | 0.375 | 0.438 | ——— | 0.531 | 0.625 | 0.718 | 0.906 | 1.125 | 1.312 | 1.406 | 1.594 |
| 0.140 | 0.145 | 0.154 | 0.203 | 0.216 | 0.226 | 0.237 | 0.258 | 0.280 | 0.322 | 0.365 | 0.375 | 0.375 | 0.375 |
| 0.191 | 0.200 | 0.218 | 0.276 | 0.300 | 0.318 | 0.337 | 0.375 | 0.432 | 0.500 | 0.500 | 0.500 | 0.500 | 0.500 |
| 0.382 | 0.400 | 0.436 | 0.552 | 0.600 | ——— | 0.674 | 0.750 | 0.864 | 0.875 | ——— | ——— | ——— | ——— |
| 0.065 | 0.065 | 0.065 | 0.083 | 0.083 | 0.083 | 0.083 | 0.109 | 0.109 | 0.109 | 0.134 | 0.165 | ——— | ——— |
| 0.109 | 0.109 | 0.109 | 0.120 | 0.120 | 0.120 | 0.120 | 0.134 | 0.134 | 0.148 | 0.165 | 0.180 | ——— | ——— |
| 0.140 | 0.145 | 0.154 | 0.203 | 0.216 | 0.226 | 0.237 | 0.258 | 0.280 | 0.322 | 0.365 | 0.375 | ——— | ——— |
| 0.191 | 0.200 | 0.218 | 0.276 | 0.300 | 0.318 | 0.337 | 0.375 | 0.432 | 0.500 | 0.500 | 0.500 | ——— | ——— |

# CAST IRON

**One of the oldest pipe materials is cast iron; 60 years ago it represented 95% of all pipe installed. Today its major application is in water and gas distribution and sewage disposal.** High resistance to soil corrosion puts it ahead for underground service, where flexibility of usual bell-and-spigot joints permits some ground settling without creating leaks. Leaded-okum joints are good up to 200 psig on water but limited to about ten psig on gas. Several mechanical variations of bell-and-spigot joints are available for special needs. Above ground, pipe systems are usually flanged for strength.

Cast-iron pipe is made in three ways: (1) vertically pit cast in dry-sand molds (2) horizontally cast in greensand molds or (3) centrifugally cast in greensand or permanent molds. Methods 2 and 3 are most popular.

Several pipe coatings are used. Standard is a hot-applied tar-pitch varnish for water service. But gas pipe is uncoated or coated outside only. Cement linings (low lime, high silica) reduce water tuberculation, but hydraulic allowance must be made for reduced diameter.

## Standard weights and thicknesses of cast-iron piping

| Nominal pipe size, in. | 3 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **50-psig class** | | | | | | | | | | | |
| Outside dia, in. | 3.96 | 4.80 | 6.90 | 9.05 | 11.10 | 13.20 | 15.30 | 17.40 | 19.50 | 21.60 | 25.80 |
| Thickness, in. | 0.32 | 0.35 | 0.38 | 0.41 | 0.44 | 0.48 | 0.48 | 0.54 | 0.54 | 0.57 | 0.63 |
| Average weight, lb per ft | 12.00 | 16.10 | 25.50 | 37.00 | 49.00 | 63.50 | 74.00 | 94.50 | 107.00 | 125.00 | 165.00 |
| **100-psig class** | | | | | | | | | | | |
| Outside dia, in. | 3.96 | 4.80 | 6.90 | 9.05 | 11.10 | 13.20 | 15.30 | 17.40 | 19.50 | 21.60 | 25.80 |
| Thickness, in. | 0.32 | 0.35 | 0.38 | 0.41 | 0.44 | 0.48 | 0.51 | 0.54 | 0.58 | 0.62 | 0.68 |
| Average weight, lb per ft | 12.00 | 16.10 | 25.50 | 37.00 | 49.00 | 63.50 | 78.50 | 94.50 | 114.00 | 135.00 | 177.00 |
| **150-psig class** | | | | | | | | | | | |
| Outside dia, in. | 3.96 | 4.80 | 6.90 | 9.05 | 11.10 | 13.20 | 15.65 | 17.80 | 19.92 | 22.06 | 26.32 |
| Thickness, in. | 0.32 | 0.35 | 0.38 | 0.41 | 0.44 | 0.48 | 0.51 | 0.54 | 0.58 | 0.62 | 0.73 |
| Average weight, lb per ft | 12.00 | 16.10 | 25.50 | 37.00 | 49.00 | 63.50 | 80.50 | 97.00 | 116.00 | 138.00 | 193.00 |
| **200-psig class** | | | | | | | | | | | |
| Outside dia, in. | 3.96 | 4.80 | 6.90 | 9.05 | 11.10 | 13.20 | 15.65 | 17.80 | 19.92 | 22.06 | 26.32 |
| Thickness, in. | 0.32 | 0.35 | 0.38 | 0.41 | 0.44 | 0.48 | 0.58 | 0.58 | 0.63 | 0.67 | 0.79 |
| Average weight, lb per ft | 12.00 | 16.10 | 25.50 | 37.00 | 49.00 | 63.50 | 86.00 | 103.00 | 126.00 | 148.00 | 208.00 |
| **250-psig class** | | | | | | | | | | | |
| Outside dia, in. | 3.96 | 4.80 | 6.90 | 9.05 | 11.10 | 13.20 | 15.65 | 17.80 | 19.92 | 22.06 | 26.32 |
| Thickness, in. | 0.32 | 0.35 | 0.38 | 0.41 | 0.44 | 0.52 | 0.59 | 0.63 | 0.68 | 0.72 | 0.79 |
| Average weight, lb per ft | 12.00 | 16.10 | 25.50 | 37.00 | 49.00 | 68.50 | 92.00 | 111.00 | 135.00 | 158.00 | 208.00 |
| **300-psig class** | | | | | | | | | | | |
| Outside dia, in. | 3.96 | 4.80 | 6.90 | 9.05 | 11.10 | 13.20 | 15.65 | 17.80 | 19.92 | 22.06 | 26.32 |
| Thickness, in. | 0.32 | 0.35 | 0.38 | 0.41 | 0.48 | 0.52 | 0.59 | 0.68 | 0.73 | 0.78 | 0.85 |
| Average weight, lb per ft | 12.00 | 16.10 | 25.50 | 37.00 | 53.00 | 68.50 | 92.00 | 120.00 | 144.00 | 170.00 | 222.00 |
| **350-psig class** | | | | | | | | | | | |
| Outside dia, in. | 3.96 | 4.80 | 6.90 | 9.05 | 11.10 | 13.20 | 15.65 | 17.80 | 19.92 | 22.06 | 26.32 |
| Thickness, in. | 0.32 | 0.35 | 0.38 | 0.41 | 0.52 | 0.56 | 0.64 | 0.68 | 0.79 | 0.84 | 0.92 |
| Average weight, lb per ft | 12.00 | 16.10 | 25.50 | 37.00 | 57.00 | 73.00 | 98.50 | 120.00 | 156.00 | 184.00 | 241.00 |

Average weight per ft values are based on 12-ft sections and include weight of bell-and-spigot joints

## Standard cast-iron flanges—150 lb

| Nominal dia, in. | Dia of flange, in. | Dia of bolt circle, in. | Number of bolts | Dia of bolts, in. | Thickness of flange, in. |
|---|---|---|---|---|---|
| 3 | 7½ | 6 | 4 | ⅝ | ⅝ |
| 4 | 9 | 7½ | 8 | ⅝ | 15/16 |
| 6 | 11 | 9½ | 8 | ¾ | 1 |
| 8 | 13½ | 11¾ | 8 | ¾ | 1⅛ |
| 10 | 16 | 14¼ | 12 | ⅞ | 1³/₁₆ |
| 12 | 19 | 17 | 12 | ⅞ | 1¼ |
| 14 | 21 | 18¾ | 12 | 1 | 1⅜ |
| 16 | 23½ | 21¼ | 16 | 1 | 1⅜ |
| 18 | 25 | 22¾ | 16 | 1¼ | 1⅜ |
| 20 | 27½ | 25 | 20 | 1⅛ | 1⁷/₁₆ |
| 24 | 32 | 29½ | 20 | 1¼ | 1⅝ |
| 30 | 38¾ | 36 | 28 | 1¼ | 2⅛ |
| 36 | 46 | 42¾ | 32 | 1½ | 2⅜ |
| 42 | 53 | 49½ | 36 | 1½ | 2⅝ |
| 48 | 59½ | 56 | 44 | 1½ | 2¾ |

## Extra-heavy cast-iron flanges—250 lb

| Nominal dia, in. | Dia of flange, in. | Dia of bolt circle, in. | Number of bolts | Dia of bolts, in. | Thickness of flange, in. |
|---|---|---|---|---|---|
| 3 | 8¼ | 6⅝ | 8 | ⅝ | 1⅛ |
| 4 | 10 | 7⅞ | 8 | ¾ | 1⅛ |
| 6 | 12½ | 10⅝ | 12 | ¾ | 1³/₁₆ |
| 8 | 15 | 13 | 12 | ⅞ | 1⅜ |
| 10 | 17½ | 15¼ | 16 | 1 | 1⅜ |
| 12 | 20½ | 17¾ | 16 | 1⅛ | 2 |
| 14 | 23 | 20¼ | 20 | 1⅛ | 2⅛ |
| 16 | 25½ | 22½ | 20 | 1¼ | 2¼ |
| 18 | 28 | 24¾ | 24 | 1¼ | 2⅜ |
| 20 | 30½ | 27 | 24 | 1¼ | 2⅜ |
| 24 | 36 | 32 | 24 | 1½ | 2¾ |
| 30 | 43 | 39¼ | 28 | 1¾ | 3 |
| 36 | 50 | 46 | 32 | 2 | 3⅜ |
| 42 | 57 | 52¾ | 36 | 2 | 3¹³/₁₆ |
| 48 | 65 | 60¾ | 40 | 2 | 4 |

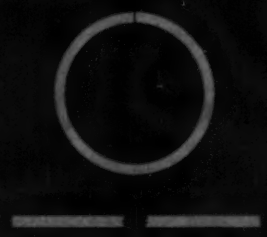
# WROUGHT IRON

**Physically mixing highly purified iron and a glasslike silicate makes wrought iron. Its structure gives it a high resistance to corrosion.** Mixture (approximately 97% iron, 2.5% silica slag and 0.5% impurities) is worked until the silicate forms millions of tiny threads throughout the wrought-iron mass. Wrought iron is fibrous and when bent and broken looks just like the break in a piece of tough, resilient hickory wood.

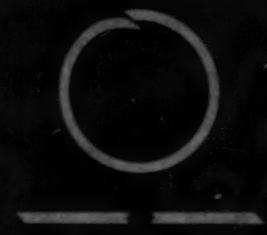
It is the threads of silicate that give wrought iron its special properties of corrosion resistance. Being immune to corrosion themselves, they stop pitting corrosion and force corrosion of the iron to proceed evenly—therefore more slowly, extending life of the piping.

Pipe is made by forming a *skelp* (specially prepared slab of wrought iron) into a pipe shape and then welding the seam. Several welding methods are shown at right. Pipe in 1¼-, 1½- and 2-in. sizes usually is available in either butt or lap weld except in double-extra-strong weight; butt-weld pipe, however, is usually provided unless you specify another type. Wrought-iron pipe in 14-in. sizes and up is fusion welded; here pipe sizes reflect actual OD. These larger sizes are made from standard wrought-iron plate, so pipe thicknesses usually agree with standard plate thicknesses rather than special skelp thicknesses used for smaller pipe.

Wrought-iron fittings are available from some fabricators, but their high cost dictates fittings of some comparable material wherever possible.



**BUTT-WELD PIPE** is formed by drawing a hot skelp through dies. Edges aren't beveled; drawing produces parallel edges at weld



**LAP-WELD PIPE** is formed by drawing beveled skelp through dies. Bevel gives overlap at joint, drawing produces tight weld

**FUSION-WELD PIPE** is rolled from standard plate. Gap is fill-welded to seal joint. Method is used in sizes over 12 in.

## Hydrostatic-test pressures for welded wrought-iron pipe

| Nominal size, in. incl | ⅛ to 1 | 1¼ to 3 | 3½ to 4 | 4½ to 8 | 10 to 12 |
|---|---|---|---|---|---|
| **Standard pipe** | | | | | |
| Butt welded | 700 | 800 | 1200 | —— | —— |
| Lap welded | —— | 1000 | 1200 | 1200 | 1000 |
| **X strong pipe** | | | | | |
| Butt welded | 850 | 1100 | 1700 | —— | —— |
| Lap welded | —— | 1500 | 1700 | 1700 | 1600 |
| **XX strong pipe** | | | | | |
| Butt welded | 1000 | 1200 | —— | —— | —— |
| Lap welded | —— | 1800 | 2000 | 2000 | —— |

## Dimensions and weights of welded wrought-iron pipe

| | Nominal pipe size, in. | ⅛ | ¼ | ⅜ | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8* | 10* | 12* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Outside diameter, in. | 0.540 | 0.675 | 0.840 | 1.050 | 1.315 | 1.660 | 1.900 | 2.375 | 2.875 | 3.500 | 4.000 | 4.500 | 5.563 | 6.625 | 8.625 | 10.750 | 12.750 | |
| **Pipe schedule number** | | | | | | | | | | | | | | | | | | | |
| 30 | thickness | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | 0.283 | 0.313 | 0.336 |
| | wt per ft, lb | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | 24.700 | 34.240 | —— |
| 40 | thickness | 0.090 | 0.093 | 0.111 | 0.115 | 0.136 | 0.143 | 0.148 | 0.157 | 0.207 | 0.221 | 0.231 | 0.242 | 0.263 | 0.268 | 0.329 | 0.372 | 43.770 | |
| | wt per ft, lb | 0.420 | 0.570 | 0.850 | 1.130 | 1.680 | 2.270 | 2.270 | 3.650 | 5.790 | 7.580 | 9.100 | 10.790 | 14.610 | 18.790 | 28.550 | 40.480 | —— | |
| 60 | thickness | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | 0.510 | —— |
| | wt per ft, lb | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— | 54.740 | —— |
| 80 | thickness | 0.124 | 0.129 | 0.151 | 0.157 | 0.183 | 0.196 | 0.204 | 0.223 | 0.282 | 0.306 | 0.325 | 0.344 | 0.383 | 0.441 | —0.510 | —— | —— | —— |
| | wt per ft, lb | 0.540 | 0.740 | 1.090 | 1.470 | 2.170 | 3.000 | 3.630 | 5.020 | 7.660 | 10.250 | 12.510 | 14.980 | 20.780 | 28.570 | 43.390 | —— | —— | —— |
| **Wall-thickness designation** | | | | | | | | | | | | | | | | | | | |
| S | thickness | 0.090 | 0.093 | 0.111 | 0.115 | 0.136 | 0.143 | 0.148 | 0.157 | 0.207 | 0.221 | 0.231 | 0.242 | 0.263 | 0.268 | —— | —— | —— | —— |
| | wt per ft, lb | 0.420 | 0.570 | 0.850 | 1.130 | 1.680 | 2.270 | 2.270 | 3.650 | 5.790 | 7.580 | 9.100 | 10.790 | 14.610 | 18.790 | —— | —— | —— | —— |
| XS | thickness | 0.124 | 0.129 | 0.151 | 0.157 | 0.183 | 0.196 | 0.204 | 0.223 | 0.282 | 0.306 | 0.325 | 0.344 | 0.383 | 0.441 | 0.511 | 0.510 | 0.510 | |
| | wt per ft, lb | 0.540 | 0.740 | 1.090 | 1.470 | 2.170 | 3.000 | 3.630 | 5.020 | 7.660 | 10.250 | 12.510 | 14.980 | 20.780 | 28.570 | 43.390 | 54.740 | 65.420 | |
| XXS | thickness | —— | —— | 0.307 | 0.318 | 0.369 | 0.393 | 0.411 | 0.447 | 0.567 | 0.615 | 0.651 | 0.690 | 0.768 | 0.884 | 0.895 | —— | —— | |
| | wt per ft, lb | —— | —— | 1.710 | 2.440 | 3.660 | 5.210 | 6.410 | 9.030 | 13.700 | 18.580 | 22.850 | 27.540 | 38.550 | 53.160 | 72.420 | —— | —— | |

* In 8-, 10- and 12-in. sizes, heavier wall thicknesses are available as standard-weight pipe

Wrought-iron pipe in sizes larger than 12 in. is usually described by its outside diameters in even in. and is made from standard plate thicknesses as required. Thicknesses of all sizes shown on this table are slightly greater than those of corresponding steel-pipe sizes. This compensates for difference in weight per cu ft between steel and wrought iron

# COPPER ALLOYS

**Brass, bronze and other copper-alloy pipe and tube comes in a wide variety of analyses to meet many low- and moderate-temperature services.** There are two ways to make it: In the *extrusion* process a heated billet is placed in a press and two concentric rams bear on it. Smaller ram pierces the billet, forming the inside surface; larger ram forces the billet through an annular space between small ram and a die. In the *Mannesmann* process, used especially for heavy-walled tubing, two convex-tapered rolls force billet over a piercing mandrel. Roll centers are not quite parallel; thus billet rotates while tube is formed.

Makeup of a few typical copper alloys is shown at right. There is almost infinite variation available in these alloys, and more are constantly becoming available to meet increasingly severe operating conditions.

**Red brass** is used in water lines, waste-heat exchangers, fuel lines and lube-oil and compressed-air coolers.

**Muntz metal** is an old familiar still giving excellent service with clean fresh water. High zinc content makes muntz metal resistant to $H_2S$ and other sulfur compounds. Addition of a small amount of arsenic helps resist dezincification—discussed on next page.

**Admiralty** is one of the oldest alloys for sea-water heat exchangers. Originally specified by the British Navy (hence its name), it was introduced to the United States during the late 19th century. Admiralty is used extensively in evaporators, condensers and condensate and air coolers, and in fresh-water applications where pollution causes corrosion problems. A trace of arsenic or phosphorus is added to slow dezincification. Recently a similar alloy, using mercury instead of arsenic for inhibitor, has shown good antibiofouling characteristics, especially for services where it comes up against warm, brackish water.

**Aluminum brass** is gaining ground over admiralty because of better resistance to some types of sea-water corrosion. This is especially true in polluted harbor waters contaminated by industrial waste. Al-brass is also more resistant to high-velocity sea water and gives better performance where impingement damage has been a problem. Here again, addition of a trace of arsenic inhibits dezincification, particularly where chlorination is used for slime and algae control.

**Copper silicon alloys** are widely used in sewage- and water-treatment plants. They are highly resistant to specialized corrosion problems found there.

**Cupro-nickel alloys** are harder and more resistant to cracking than the other copper blends. In addition, they're better able to resist ammonia attack. But they're not as good as aluminum bronze in resistance to general power-plant corrosion problems. A variety of high-nickel

## Typical copper alloys

| Material | Nominal composition, % | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cu | Zn | Sn | Al | Ni | Mn | Other |
| Red brass | 85.00 | 15.00 | — | — | — | — | — |
| Muntz metal | 60.00 | 40.00 | — | — | — | — | — |
| Arsenical admiralty | 71.00 | 27.96 | 1.00 | — | — | — | Arsenic 0.04 |
| Aluminum brass | 78.00 | 19.97 | — | 2.00 | — | — | Arsenic 0.03 |
| Copper-silicon | 95.80 | — | — | — | — | 1.10 | Silicon 3.10 |
| Cupro-nickel | 88.35 | — | — | — | 10.00 | 0.40 | Iron 1.25 |

## Copper-alloy pipe dimensions and maximum-pressure ratings

| | Nominal pipe size, in. | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ⅛ | ¼ | ⅜ | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8 | 10 |
| | Outside diameter, in. | | | | | | | | | | | | | | | | |
| | 0.405 | 0.540 | 0.675 | 0.840 | 1.050 | 1.315 | 1.660 | 1.900 | 2.375 | 2.875 | 3.500 | 4.000 | 4.500 | 5.562 | 6.625 | 8.625 | 10.750 |
| **Regular pipe** | | | | | | | | | | | | | | | | | |
| Thickness, in. | 0.062 | 0.082 | 0.090 | 0.107 | 0.114 | 0.126 | 0.146 | 0.150 | 0.156 | 0.187 | 0.219 | 0.250 | 0.250 | 0.250 | 0.250 | 0.312 | 0.365 |
| Allowable pressure for threaded ends, psig | | | | | | | | | | | | | | | | | |
| 200 F | 370 | 870 | 890 | 900 | 810 | 630 | 690 | 630 | 540 | 450 | 510 | 570 | 510 | 410 | 340 | 360 | 360 |
| 300 F | 320 | 760 | 780 | 790 | 710 | 560 | 610 | 560 | 480 | 390 | 450 | 500 | 440 | 360 | 300 | 320 | 320 |
| 400 F | 140 | 330 | 340 | 340 | 310 | 240 | 260 | 240 | 210 | 170 | 190 | 220 | 190 | 160 | 130 | 140 | 140 |
| Allowable pressure for plain ends, psig | | | | | | | | | | | | | | | | | |
| 200 F | 2640 | 2610 | 2280 | 2160 | 1800 | 1580 | 1440 | 1280 | 1050 | 1040 | 1000 | 1000 | 880 | 710 | 600 | 560 | 520 |
| 300 F | 2310 | 2290 | 1990 | 1890 | 1570 | 1380 | 1260 | 1120 | 920 | 910 | 880 | 880 | 770 | 620 | 520 | 490 | 450 |
| 400 F | 990 | 980 | 860 | 810 | 680 | 600 | 540 | 480 | 400 | 390 | 380 | 380 | 330 | 270 | 230 | 210 | 200 |
| **Extra-strong pipe** | | | | | | | | | | | | | | | | | |
| Thickness, in. | 0.100 | 0.123 | 0.127 | 0.149 | 0.157 | 0.182 | 0.194 | 0.203 | 0.221 | 0.280 | 0.304 | 0.321 | 0.341 | 0.375 | 0.437 | 0.500 | 0.500 |
| Allowable pressure for threaded ends, psig | | | | | | | | | | | | | | | | | |
| 200 F | 1960 | 2210 | 1840 | 1760 | 1510 | 1340 | 1160 | 1090 | 1000 | 970 | 910 | 860 | 840 | 770 | 800 | 710 | 550 |
| 300 F | 1710 | 1930 | 1610 | 1540 | 1320 | 1180 | 1020 | 960 | 870 | 850 | 780 | 750 | 730 | 670 | 700 | 620 | 490 |
| 400 F | 740 | 830 | 690 | 660 | 570 | 510 | 440 | 410 | 380 | 370 | 340 | 330 | 320 | 290 | 300 | 270 | 210 |
| Allowable pressure for plain ends, psig | | | | | | | | | | | | | | | | | |
| 200 F | 4630 | 4200 | 3360 | 3130 | 2560 | 2360 | 1950 | 1770 | 1520 | 1600 | 1420 | 1300 | 1230 | 1080 | 1060 | 910 | 710 |
| 300 F | 4050 | 3680 | 2930 | 2740 | 2240 | 2060 | 1700 | 1550 | 1330 | 1400 | 1240 | 1140 | 1070 | 950 | 930 | 790 | 620 |
| 400 F | 1740 | 1580 | 1260 | 1180 | 960 | 890 | 730 | 670 | 570 | 600 | 540 | 490 | 460 | 410 | 410 | 340 | 270 |

alloys (up to 30%) are available, but during World War II when nickel was at a premium it was found that the nickel content can be reduced if a small amount of iron is added as an alloying element.

Duplex tubing meets special corrosion problems. Inner and outer tubes of different alloys are drawn together to make a tight bond. Thus two materials can be used in one tube to meet particular corrosion problems both within and without. Any combination can be used, including copper or copper alloys bonded with other nonferrous metals or steel. At tube ends, outside material should be cut back and replaced by a ferrule of the same material as inside tube. To prevent galvanic corrosion, actual cutback should be designed so that both tube and ferrule will be securely rolled into tube sheet.

Dual-gage tubing is designed with a thicker wall at inlet end; there's more material where corrosion is greatest. This specialty is best used where you find uniform corrosion at inlet end only. It has little advantage where pitting corrosion or the effects of impingement are experienced. Increased velocity produced by dual-gage tubing is not enough to affect tube life adversely.

**Dezincification** is a very special kind of corrosion occurring in zinc-bearing copper alloys. The alloy actually dissolves and copper redeposits as pure metal—but in porous form. Zinc may be carried away as soluble salts or deposited in place as insoluble compounds.

There are two classes of dezincification, general—layer type, and localized—plug type. Layer dezincification tends to occur more often in acid environments while plug type occurs in alkaline or neutral situations.

Improper rolling of copper-alloy tubes in tube sheets of surface condensers or heaters can produce stress corrosion—cracking. This is usually caused by overexpanding tube to fit too-large tube-sheet hole. In general, tube-sheet holes should be drilled and reamed no larger than 0.005- to 0.010-in. greater than tube OD.

Recent interest has focused on welded tube-to-tube-sheet construction. Tube may be partially rolled-in to prevent crevice corrosion on back side of tube sheet. Many specialized techniques and special equipment are available for this operation. Principal application so far has been with large-surface condensers—particularly in nuclear-power plants—where water cannot be allowed to leak in.

Note that standard copper-alloy pipe dimensions do not hold for condenser tubes. Rather, tube sizes agree with actual OD dimensions held to very close tolerances.

# COPPER TUBING

**Standards for copper tubing differ from copper-alloy pipe and tube. You can order both hard and soft tubing, but chemically there is only one quality—99.9%+ pure copper.** Popularity of copper tubing is based on ease of field erection. Type designations show wall thickness only (in in., equal to Bwg).

**Type K** can be either hard or soft. It is recommended for water, gas, steam and hot-water systems, also used extensively for underground service.

**Type L** is available hard or soft. It is used for relatively less severe services than K.

**Type M** is supplied in hard temper only. Its main use is in interior heating and low-pressure service.

**Type DWV** (drainage-waste-vent) is new. Specifically designed for drain and vent lines, it's available in hard temper only.

Threadless pipe (IPS size water tubing) is available for general plumbing applications.

All tubing can be supplied straight in 20-ft lengths. Soft-tempered types K and L also come in 60-ft coils up to 1½-in. size, and 2-in. tubing in shorter coils.

Allowable pressures based on accepted maximum-working-stress values are shown below. For temperatures over 100 F use appropriate multiplying factor.

## Copper-tubing dimensions and maximum-pressure ratings

| | Nominal pipe size, in. | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 3½ | 4 | 5 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Outside diameter, in. | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 | 2.625 | 3.125 | 3.625 | 4.125 | 5.125 | 6.125 | 8.125 | 10.125 |
| **Type K** | | | | | | | | | | | | | | | | | | |
| Thickness, in. | | 0.035 | 0.049 | 0.049 | 0.049 | 0.065 | 0.065 | 0.065 | 0.072 | 0.083 | 0.095 | 0.109 | 0.120 | 0.134 | 0.160 | 0.192 | 0.271 | 0.338 |
| Allowable pressure at 100 F | | 1060 | 1170 | 920 | 760 | 880 | 680 | 550 | 520 | 450 | 420 | 410 | 380 | 370 | 360 | 370 | 390 | 390 |
| **Type L** | | | | | | | | | | | | | | | | | | |
| Thickness, in. | | 0.030 | 0.035 | 0.040 | 0.043 | 0.045 | 0.050 | 0.055 | 0.060 | 0.070 | 0.080 | 0.090 | 0.100 | 0.110 | 0.125 | 0.140 | 0.200 | 0.250 |
| Allowable pressure at 100 F | | 900 | 800 | 740 | 650 | 590 | 510 | 460 | 430 | 370 | 350 | 330 | 320 | 300 | 280 | 260 | 280 | 290 |
| **Type M** | | | | | | | | | | | | | | | | | | |
| Thickness, in. | | ---- | 0.025 | 0.028 | ---- | 0.032 | 0.035 | 0.042 | 0.049 | 0.058 | 0.065 | 0.072 | 0.083 | 0.095 | 0.109 | 0.122 | 0.170 | 0.212 |
| Allowable pressure at 100 F | | ---- | 560 | 510 | ---- | 420 | 340 | 340 | 340 | 300 | 280 | 260 | 260 | 260 | 240 | 230 | 240 | 240 |

Allowable pressures apply to tube itself and do not take into account type of joint or joining material. Obtain approximate allowable pressures at other temperatures by multiplying values in table above: for 200 F multiply by 0.91; for 300 F multiply by 0.78; for 400 F multiply by 0.50

# OTHER PIPING MATERIALS

**In addition to steel, iron and copper, countless other piping materials are used in energy-systems piping. Some have been used for many years, but others, such as plastic pipe, are so new that their full potential is not yet developed.**

**Plastic pipe** is rapidly gaining adherents as it takes in easy stride jobs that were yesterday's trouble spots. Currently a wide spectrum of plastics is available with properties to suit many corrosive applications and general uses. Rigid and flexible pipe in several types meets specific needs. Some varieties are polyethylene, polyvinyl chloride and polyvinylidene chloride. (See POWER, September 1959, pp 65-70 for more on plastic pipe.)

Plastic-pipe joints can be screwed or "welded". Threading of pipe sections uses standard equipment; welding uses socket type fittings and a special solvent. Fittings up to about six in. are commercially available, but in the larger sizes you may have to make your own. As uses for plastic pipe expand, larger fittings will undoubtedly come on the market. Pipe lengths can be cut in the field with a hacksaw, reducing assembly costs.

Standards of the plastic-pipe industry are progressing. But this is still a new field and standards are not yet common to all manufacturers. So far, steel-pipe schedules usually serve as plastic-pipe standards. Since plastic pipe "cold creeps", ratings are set at a fixed pressure with corresponding allowable temperatures. In most cases these fall in the 120- to 140-F range. At higher temperatures, plastic pipe softens, can sag between hangers. Low maximum-temperature ratings of commercially available plastics limit their application, but new plastics now in the experimental stage may soon fill the gap.

Distance between supports must be less than for steel pipe of similar rating and vertical sections must be supported at frequent (not more than 10-ft) intervals.

Costs depend on type of plastic you need. They can vary from slightly less than carbon steel, to up to four times its price. But remember that installation is greatly simplified; overall job may cost you much less.

Plastic-pipe corrosion is an *absorption* reaction. Corrosive medium usually penetrates the plastic and results in a weight gain instead of the more-familiar weight loss.

**Aluminum pipe** and tubing is gaining popularity for its high corrosion resistance, light weight and ease of assembly. Used in place of some stainless steels, aluminum pipe can save you money.

Aluminum pipe is available in schedules 5 and 10 up to four in. and schedules 40 and 80 up to ten in. It can be welded, threaded or mechanically coupled. Aluminum tube and pipe is almost 99% pure; common alloying elements include magnesium, silicon, copper, chromium and iron. Magnesium-silicon-aluminum alloys are heat-treatable to give higher tensile strengths.

High heat conductivity of aluminum has led to wide use in heat-transfer equipment. In surface condensers it's still a somewhat experimental material, but seems to hold great promise. When you use it on steam service, be careful to avoid alkaline boiler compounds. Temperature is usually limited to 400 to 480 F.

**Asbestos-cement-fiber pipe** is pressure-formed from a combination of asbestos, cement and silica, then steam-cured for chemical stability. A smooth, homogeneous, nonmetallic section is formed having a high resistance to corrosion. Asbestos-cement pipe cuts easily and can be drilled and tapped in the field.

Several weights of pipe are available for pressures of 150, 225, 325 and 450 ft at temperatures up to 150 F. Sizes vary from three to 36 in.

Widest use is in underground water lines—high resistance to soil corrosion recommends it here. Smooth inside surface resists tuberculation and maintains a low resistance to flow. It also handles duty in air ducts and vents, especially where corrosive fumes are exhausted. Fittings are asbestos-cement couplings or lined steel.

**Wood pipe** installations have been known to operate for several hundred years. Today wood finds primary use in hydroelectric-power-station supply lines. Elsewhere it carries large quantities of water and waste materials.

Pipe, made principally of redwood, comes in three basic types: (1) Continuous-stave pipe with staggered-stave joints is available in 10-in. sizes and up, handles pressures up to 350 ft. Single bands are often used for pipe up to 48 in.; larger pipe takes multiple bands. (2) Machine-banded or wire-wound wood pipe can be bought in 2- to 24-in. sizes and is good for pressures up to 400 ft. (3) Bored pipe is limited to 1½- to 6-in. sizes and pressures up to 50 ft.

Principal benefit of wood pipe lies in ease of transport and field assembly for large piping, but air vents must be provided at high points in line to prevent collapse under vacuum. Water velocities, usually limited to five to six fps, can go as high as ten fps if water holds no erosive particles. When pipe must be laid in alkaline soils, a double kraft-paper wrapping impregnated with tar is applied to protect the wood.

**Lined pipe** is available with an almost infinite variety of liners and basic pipe materials. Metallic liners such as tin and stainless steel and nonmetallic liners such as asbestos, redwood, cement, rubber and glass have been available for some time for special corrosive services. Recent days have seen introduction of several plastic liners—Saran (up to 200 F), Penton (up to 300 F) and Teflon (up to 500 F).

Basic outside pipe material usually sets the pressure rating for the combination. Many lined-pipe designs can be either threaded or flanged. Here threading doesn't cut through the basic outside material, or liner covers the flange face; in either case continuity of the liner materials is unbroken and outside base material is completely protected from liquid handled.

**Many other materials** are available for specific applications, although they are not too common in energy-systems engineering. These include tile, glass, lead and even gold. Flexible hose, a form of pipe, is sometimes used with movable equipment. But in selecting and designing for any of them, you must cover the same points as for the more common materials. You must check their physical and chemical characteristics; availability of fittings and connectors must be known; hydraulic characteristics must be determined to set pipe sizes.

# SUPPORTS AND FITTINGS

**Pipe hangers of many types are available to control movement and support weight of piping systems. Pipe may hang from the ceiling or be supported from walls or floor.**

Rigid hangers can fasten to overhead beams or embed in concrete. If axial movement must be allowed, they can incorporate rollers. In tunnels, pipe is normally supported from the floor or hung on wall brackets.

Where dimensional changes caused by temperature variations occur in your piping system, spring type hangers combine controlled travel with load support. But the load-carrying capability of simple spring hangers varies slightly throughout travel. Where necessary you can use constant-support hangers; these have compensating springs or are arranged geometrically so spring travel varies with pipe travel to insure constant support.

A new type of hanger now available actually positions the piping system to agree with thermal expansion and relieve loads otherwise imposed on connected equipment. Slight motion in a related but remote part of system is sensed and actuates a motor which, through a reduction-gear-and-screw arrangement, moves pipe and restores proper position at control point.

Stresses imposed on piping systems and connected equipment by thermal changes can be surprisingly high. It is not uncommon for the strains produced in a poorly designed system to actually lift heavy equipment off its foundations. Be sure to consider *all* conditions your system may have to handle when you design pipe supports.

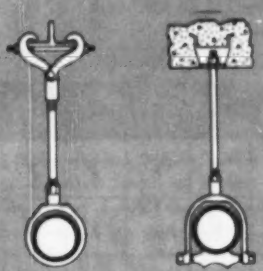
**Expansion joints give a system flexibility by permitting relative motion between pipe sections. They compensate for changes in dimension due to temperature variation or permissible motion of connected equipment.** Being flexible, they can isolate vibration, and used underground can allow for ground settling or strains of traffic loading. Most joint types permit considerable axial movement (along line of pipe) and some angular misalignment.

Bellows type expansion joints are used for low and intermediate pressures. They are pipe sections made of a ductile material such as rubber or stainless steel that permits repeated flexing without fatigue failure. Both axial and angular movement is allowable. For satisfactory service at higher pressures, the bellows can be reinforced with special bands to control radial expansion.

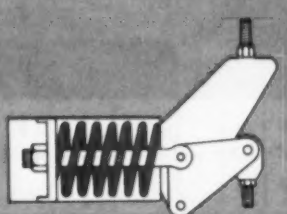
Sleeve type expansion joints are used on plain-end pipe, provide almost infinite axial movement and some angular misalignment. They can also be used to connect pipes with different diameters. For field repairs, broken pipe sections can be cut out and a replacement piece installed using two sleeve type couplings; the remainder of the pipe need not be disturbed.

Ball type joints allow for angular movement only, but you can set up two of them with a short intermediate section of pipe at 90 deg to permit axial movement. Since ball type expansion joints can be all-steel construction, they are suitable for somewhat higher pressures and temperatures than bellows or sleeve types.

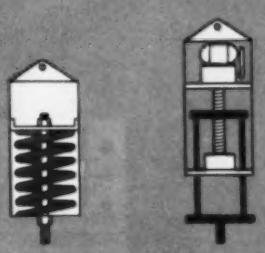
**Typical pipe supports and expansion joints in use today**



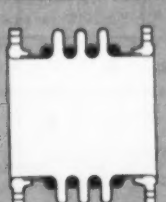
**RIGID HANGERS** are supported from I-beams or imbedded in concrete ceilings



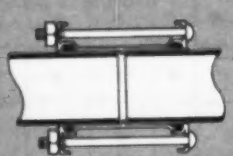
**CONSTANT-SUPPORT HANGERS** pull evenly by geometry or secondary springs



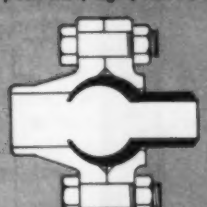
**SPRING HANGERS** allow vertical movement. Pipe positioner, right, has no springs



**BELLOWS EXPANSION JOINT** can be braced for higher operating pressure



**SLIP TYPE EXPANSION JOINT** is self-sealing, provides some angular movement



**BALL JOINTS** in series can be used instead of pipe loops for moderate pressure

**Pipe joints and fittings can easily be the most important part of your piping system. Analyze your needs carefully and then be sure to select the very best design and material for your job. Otherwise joints and fittings can cause real operating headaches and high maintenance costs.**

Variety of joints and fittings available to designers today is quite imposing. A few of the more common types and materials they're made of are shown below. Within each general classification there are many "specials" which you should check for suitability. For example, we show only two flange types, but actually there are many variations: screwed-on flanges, slip flanges welded on and VanStoned flanges held by a lap in the pipe end.

**Six methods** of pipe joining cover most energy-system applications. Variations are available, largely governed by materials and services they'll have to handle.

*Screwed connections*, most common in small low- and moderate-pressure lines, are convenient for field assembly. Threads are cut on a taper to insure tightness, and a sealing compound provides lubrication when you make up the joint and prevents rusting to ease disassembly.

*Flanges* are fastened to pipe in three basic ways. They can be (1) cast integrally with the pipe (2) fabricated separately and screwed or welded on (3) entirely separate, bearing on laps formed or welded at the pipe ends. There are also some specialized methods, such as Victaulic couplings which bear on special seals and are fixed by grooves in the pipe ends.

Integral flanges are usually limited to cast-iron and forged-steel pipe. Screwed-on flanges are popular because they simplify field erection. Pipe can be cut to suit, threaded, and flanges screwed on to match adjacent bolt holes in connected equipment. Loose flanges bearing on formed or lapped pipe ends are suitable for higher operating pressures and temperatures than screwed flanges.

*Welding* sees service at very high temperatures and pressures where cost of flanges is prohibitive—if tightness is required under all operating conditions. Exceptions are cases where frequent disassembly is necessary. Weld-end, socket-weld or a combination of both is versatile. Increased use of shop-fabricated pipe reduces number of fittings and joints to be made up in the field.

*Compression fittings* are used with tubing—copper, brass and steel. Several types are made either with a flared tube end or a wedge-shaped piece to deform tubing and seal the joint.

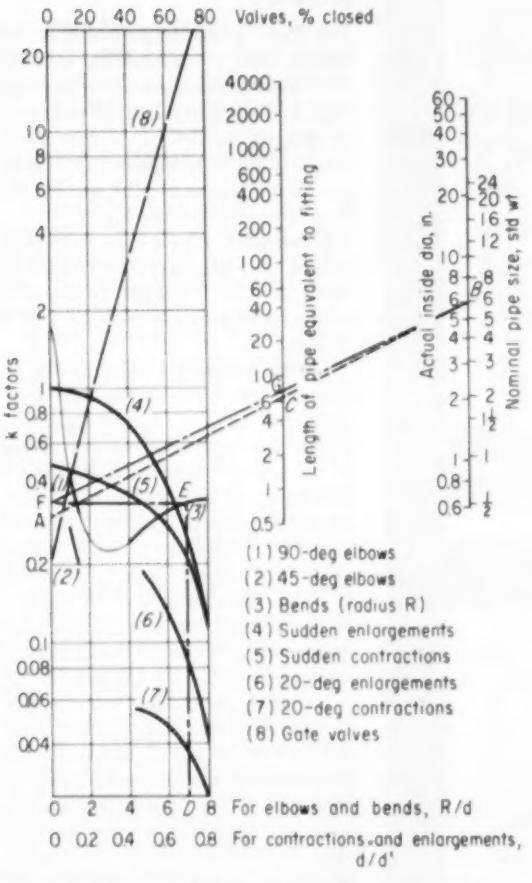
*Soldered fittings* are used with copper and brass pipe and tubing. They are sweated on and can be provided with solder already tinned in. Several types of solder are on the market; which one you choose will depend on the temperatures and pressures involved.

*Bell and spigot joints* are found in cast-iron, concrete and tile pipe. They are somewhat flexible, so if you use them underground they'll conform to normal ground settling. Most joints are packed with jute and lead for water-supply and sanitary lines. Special high-strength sealing arrangements handle higher pressures. Both AWWA and AGA have their own designs which differ principally in the grooving of the bells.

## End connections available for various materials, fittings

| End connections | Materials | | | | | | | | Fittings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Steel | Cast iron | Wrought iron | Brass, bronze | Copper | Plastic | Aluminum | Tile | 90-deg elbow | 45-deg elbow | Street elbow | Tee | Reducer (concentric) | Reducer (eccentric) | Union | 180-deg turn | Adapter | Coupling |
| Screwed | ● | ● | ● | ● | ● | ● | ● | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Flanged (flat face) | ● | ● | ● | ● | ● | ● | ● | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | |
| Flanged (raised face) | ● | ● | ● | | | | | | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | |
| Weld end | ● | | | | | | ● | | ✓ | ✓ | | ✓ | ✓ | ✓ | | | ✓ | |
| Socket weld | ● | | | ● | | ● | ● | | ✓ | ✓ | | ✓ | | | ✓ | | ✓ | ✓ |
| Bell and spigot | | ● | | | | | | ● | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | |
| Sweat on | | | | ● | ● | | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Compression tubing | ● | | | ● | | | ● | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Sleeve | | ● | | | | ● | | | | | | | | | | | | ✓ |

# FLUID LOSSES




**FITTINGS AND VALVES** are converted to equivalent lengths of straight pipe—then added to system to find total losses

**Calculation of fluid losses is necessary to determine precise pipe size. Hence this is the starting point in any piping system design—whether for liquid or gas.** It is usually best economically to keep velocities as high as possible consistent with reasonable losses. Optimum pipe size will give minimum annual charges—pumping cost plus capitalized installation cost.

Start out by picking a ball-park velocity from table below, depending on application. But remember that it will only be approximate, to be rechecked later in your calculations to arrive at best economic size.

| *Service* | *Velocity range, fps* |
|---|---|
| Service water mains | 2 to 5 |
| General-service water piping | 4 to 10 |
| Boiler-feedwater piping | 6 to 18 |
| Low-pressure steam-heating piping | 15 to 70 |
| Low-pressure steam mains | 70 to 165 |
| High-pressure steam mains | 165 to 400 |
| Steam-engine and pump piping | 100 to 150 |
| Steam-turbine piping | 150 to 330 |

Allowable velocity increases somewhat with pipe diameter, so recheck velocity $V$ from table below, using nominal pipe diameter $d$:

| | |
|---|---|
| Pump discharge lines, fps | $V = (d/2) + 4$ |
| Pump suction lines, fps | $V = 1/3\ (d/2) + 4$ |
| Steam lines, 1000 fpm | $V = d$ |

Knowing approximate velocity, solve for pipe size:

$$\text{ID of pipe} = \sqrt{\frac{0.409 \times \text{gpm}}{\text{velocity, fps}}}$$

Then go to nomograph, left, to find equivalent lengths of fittings, add to straight pipe in system and figure losses from nomographs on next two pages.

Have you figured reasonable losses? If not, try a larger or smaller pipe size and begin again.

## How to convert fitting losses into equivalent length of straight pipe

**Example:** 6-in. water line includes one 90-deg welding elbow and one 3-ft 6-in. radius bend. What is equivalent length of straight pipe?

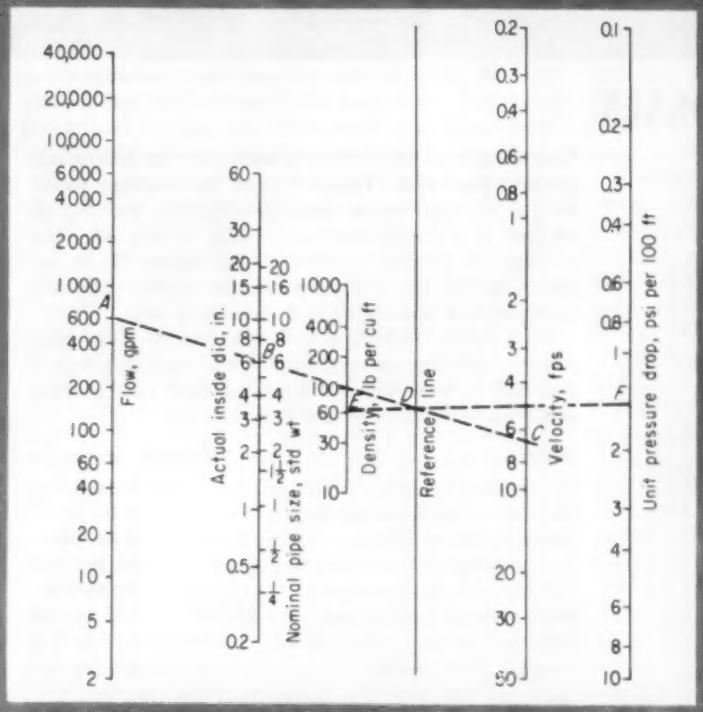
For the elbow, $k$ value is 0.32 (point *A*, nomograph above). Connect with 6-in. point on right side of pipe scale (*B*). Intersection of line *AB* and equivalent-length scale shows 6½ ft (*C*).

For 3-ft 6-in. bend, $R/r = 42/6 = 7$. Enter bottom of chart at $R/r = 7$ (*D*) and project up to "bends" curve (*E*), then across to $k$ scale where $k = 0.355$ (*F*). Connect *F* with 6-in. point on right side of pipe scale (*B*). Intersection of line *FB* and equivalent-length scale shows 7½ ft (*G*).

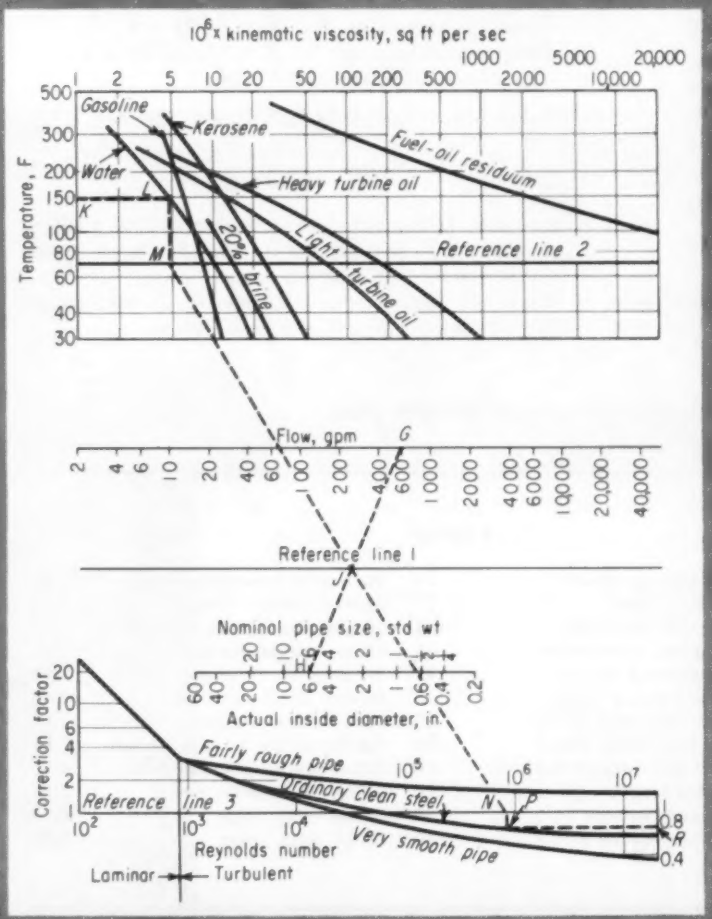
Total equivalent length of fittings in this piping system is then $7\frac{1}{2} + 6\frac{1}{2} = 13$ ft. Add this 13-ft equivalent length to actual pipe length in system, come up with total losses.

| Fitting | k factor | | |
|---|---|---|---|
| 45-deg welding elbow | .21 | 90-deg double-mitre elbow | .60 |
| Gate valve, open | .21 | 45-deg lateral through branch | .75 |
| 90-deg welding elbow | .32 | 90-deg standard screwed elbow | .92 |
| Welding tee, through run | .40 | Submerged discharge | 1.00 |
| 45-deg screwed elbow | .42 | Welding tee, through branch | 1.40 |
| 180-deg welding return | .42 | 90-deg single-mitre elbow | 1.70 |
| 45-deg single-mitre elbow | .45 | Screwed tee, through branch | 1.80 |
| 90-deg triple-mitre elbow | .45 | Fabricated tee, through branch | 1.80 |
| Screwed tee, through run | .50 | 180-deg close-screwed return | 2.00 |
| Fabricated tee, through run | .50 | Swing-check valve, open | 2.50 |
| Submerged entrance | .50 | Angle valve, open | 4.00 |
| 90-deg long-sweep elbow | .60 | Globe valve, open | 10.00 |

# Calculate flow velocity and pressure drop before trying




**1** **TO ESTIMATE LIQUID LOSSES** connect any two values: flow, velocity, pipe size. Extended line through density and reference points shows the pressure drop




**1a** **CORRECTION FACTOR** refines liquid-loss estimation obtained from Fig. 1 by accounting for viscosity, temperature and character of the pipe surface

## LIQUIDS

**For fluid losses in liquid systems where flow is turbulent, usually the case in energy-system piping, Fig. 1 alone gives a good estimate of piping losses.** If a very accurate loss figure is required or if laminar flow is known to exist, use Fig. 1a to correct results from Fig. 1.

**Example:** a new 6-in. standard-weight steel line carries 600 gpm of water at 150 F. What is the flow velocity and pressure drop per 100 ft of pipe?

**Quick estimate:** refer to Fig. 1. Connect 600 gpm on the flow scale (point *A*) to 6 in. on the right side of the pipe scale (*B*) and extend line to the velocity scale (*C*), showing a velocity of 6.7 fps. At the same time, establish intercept with the reference line (*D*). Connect *D* with proper value on the density scale (*E*). Water at 150 F has a density of 61.2 lb per cu ft. Extend this line to the unit-pressure-drop scale (*F*) and read a pressure drop of 1.4 psi per 100 ft.

**Accurate solution:** refer to Fig. 1a. Connect 600 gpm on flow scale (*G*) to 6 in. on top of pipe scale (*H*) and establish the intercept on reference line 1 (*J*). Enter temperature scale at 150 F and project horizontally to the water line (*L*), then down to reference line 2 (*M*). Connect points *M* and *J* and extend the line down to Reynolds Number reference line 3 (see below). Project down from *N* to the line for ordinary clean steel (*P*) and read 0.72 on correction-factor scale (*R*).

Corrected pressure drop, therefore, is $1.4 \times 0.72 = 1.01$ psi per 100 ft of 6-in. pipe.

### Reynolds Number

Note that reference line 3 in Fig. 1a is a plot of the Reynolds Number—a dimensionless number whose magnitude indicates flow type. Below $R = 900$, flow is laminar in nature. Between $R = 900$ and $R = 4000$ (approximately) is a transition zone which is treated in Fig. 1a as part of the turbulent range. Above $R = 4000$, flow is definitely turbulent.

# to pin down pipe size for any part of your plant system

## STEAM AND GASES

**For fluid losses in gas and steam systems, use Fig. 2 alone for a good estimate of piping losses.** If you need a very accurate value, correct result obtained from Fig. 2 by applying factor obtained from Fig. 2a.

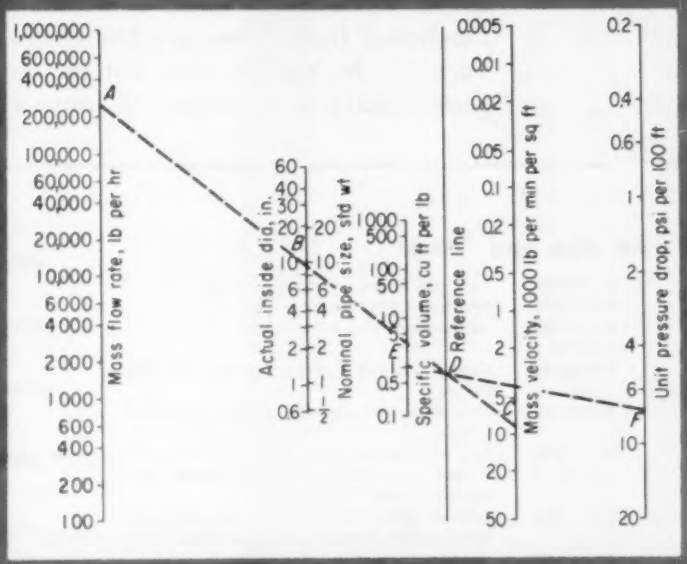
**Example:** for steam flow of 250,000 lb per hr through a 10-in. schedule-80 pipe at 635 psig and 850 F, determine velocity and pressure drop per 100 ft of pipe.

**Quick estimate:** from Steam Tables find that specific volume of steam at 635 psig and 850 F is 1.153 cu ft per lb. Now refer to Fig. 2. Connect 250,000 lb per hr on mass-flow-rate scale (point *A*) with 9.564 on right side of pipe scale (*B*) (note from steel-pipe table that inside diameter of 10-in. schedule-80 steel pipe is 9.564 in.). Extend line to the mass-velocity scale (*C*) and read 8300 lb per min per sq ft. To convert mass velocity to actual velocity, multiply mass velocity by specific volume, $8300 \times 1.153 = 9550$ fpm. Now connect the intercept at reference line (*D*) to 1.153 point on the specific-volume scale (*E*) and extend line to the unit-pressure-drop scale, reading 7.2 psi per 100 ft (*F*).

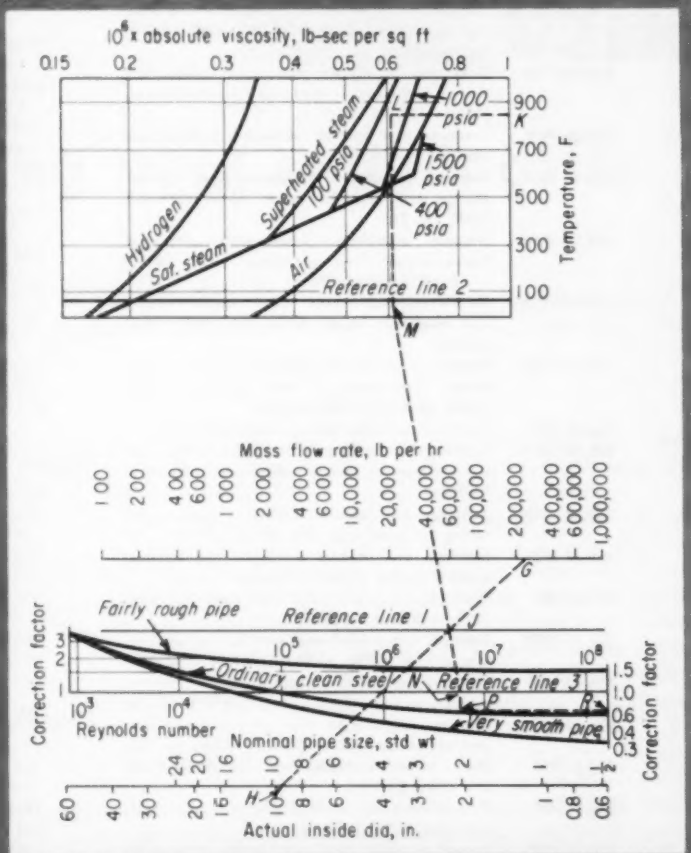
**Accurate solution:** refer to Fig. 2a. Connect 250,000 lb per hr on the mass-flow-rate scale (*G*) with 9.564 in. on the bottom of the pipe scale (*H*) and note the intercept with reference line 1 (*J*). Enter temperature scale of the viscosity chart at 850 F (*K*) and interpolate 650 psig between the 400-psig and 1000-psig lines (*L*). Drop down to reference line 2 (*M*). Connect point *M* to *J* and extend to reference line 3 (*N*). Drop down to line for ordinary clean-steel pipe (*P*) and read correction factor of 0.62 (point *R*).

Corrected pressure drop therefore is $0.62 \times 7.2 = 4.5$ psi per 100 ft.

Same procedure applies in accurate solution for air- or hydrogen-carrying piping. For other gases, determine temperature vs absolute-viscosity characteristics over a range and plot on graph (Fig. 2a). Then solve in normal way.




**2** **TO ESTIMATE STEAM OR GAS LOSSES** connect pipe size with mass flow rate or mass velocity. Extended line through $V_s$ and reference point shows losses




**2a** **CORRECTION FACTOR** refines estimated steam or gas losses obtained from Fig. 1 by accounting for temperature, viscosity and character of pipe surface

# ASA PIPING STANDARDS

**Latest editions of selected standards listed below may be purchased from American Standards Assn, 70 E 45th St, New York 17, N. Y. List may not be complete or up to date for your specific application, so inquire of ASA before ordering**

## Steel pipe and fittings

| | |
|---|---|
| B16.5-1957 | Steel pipe flanges and flanged fittings |
| B16.9-1958 | Steel butt-welding fittings |
| B16.11-1946 R1952 | Steel socket-welding fittings |
| B16.20-1956 | Ring-joint gaskets and grooves for steel pipe flanges |
| B16.25-1958 | Butt-welding ends for pipe, valves, flanges and fittings |
| B31.1-1955 | Code for pressure piping (sections 1 through 7) |
| B36.1-1959 | Welded and seamless steel pipe (ASTM A53-58, ASME SA-53) |
| B36.3-1956 | Seamless carbon-steel pipe for high-temperature service (ASTM A106-55T, ASME SA-106) |
| B36.10-1959 | Wrought-steel and wrought-iron pipe |
| B36.11-1958 | Electric-fusion-welded steel pipe for high-temperature service (ASTM A155-56T) |
| B36.16-1956 | Spiral-welded steel or iron pipe (ASTM A211-54) |
| B36.18-1958 | Seamless alloy-steel boiler, superheater and heat-exchanger tubes (ASTM A213-55T, ASME SA-213) |
| B36.19-1957 | Stainless-steel pipe |
| B36.20-1958 | Black and hot-dipped zinc-coated (galvanized) welded and seamless steel pipe for ordinary uses (ASTM A120-54) |
| B36.26-1956 | Seamless and welded austenitic stainless-steel pipe (ASTM A312-55) |
| B36.28-1959 | Seamless cold-drawn low-carbon-steel heat-exchanger and condenser tubes (ASTM A179-56T, ASME SA-179) |
| B36.29-1959 | Seamless cold-drawn intermediate alloy-steel heat-exchanger and condenser tubes (ASTM A199-56T, ASME SA-199) |
| B36.32-1959 | Electric-resistance-welded steel heat-exchanger and condenser tubes (ASTM A214-56T, ASME SA-214) |
| B36.33-1956 | Welded austenitic stainless-steel boiler, superheater, heat-exchanger and condenser tubes (ASTM A249-55T, ASME SA-249) |
| B36.35-1956 | Copper-brazed-steel tubing (ASTM A254-55T) |
| B36.36-1956 | Seamless and welded ferritic stainless-steel tubing for general service (ASTM A268-55, ASME SA-268) |
| B36.37-1956 | Seamless and welded austenitic stainless-steel tubing for general service (ASTM A269-55) |
| B36.38-1956 | Seamless and welded austenitic stainless-steel sanitary tubing (ASTM A270-55) |
| B36.4-1956 | Electric-fusion (arc) welded steel-plate pipe, sizes 16 in. and over (ASTM A134-54) |
| B36.40-1959 | Seamless and welded steel pipe for low-temperature service (ASTM A333-55T, ASME SA-333) |
| B36.41-1959 | Seamless and welded steel tubes for low-temperature service (ASTM A334-55T, ASME SA-334) |
| B36.42-1956 | Seamless ferritic-alloy steel pipe for high-temperature service (ASTM A335-55T, ASME SA-335) |
| B36.5-1956 | Electric-resistance-welded steel pipe (ASTM A135-55T, ASME SA-135) |
| B36.9-1959 | Electric-fusion (arc) welded steel pipe, sizes 4 in. and over (ASTM A139-55) |
| G17.3-1958 | Forged or rolled steel pipe flanges, forged fittings and valves and parts for high-temperature service (ASTM A105-56, ASME SA-105) |
| G37.1-1958 | Forged or rolled alloy-steel pipe flanges, forged fittings and valves and parts (ASTM A183-57T, ASME SA-182) |
| G46.1-1958 | Forged or rolled steel pipe flanges, forged fittings and valves and parts for general service (ASTM A181-57T, ASME SA-181) |
| H34.3-1955 | Nickel-chromium-iron-alloy seamless pipe and tubing (ASTM B167-49T) |

## Iron pipe and fittings

| | |
|---|---|
| A21.1-1957 | Computation of strength and thickness of cast-iron pipe (AWWA C101-57) |
| A21.10-1952 | Short-body cast-iron fittings, 3 in. to 12 incl, for 250-psi water pressure plus water hammer (AWWA C110) |
| A21.11-1953 | Mechanical joint for cast-iron pressure pipe and fittings (AWWA C111) |
| A40.5-1943 | Threaded cast-iron pipe for drainage, vent and waste services |
| B16b-1944 R1953 | Cast-iron pipe flanges and flanged fittings, class 250 |
| B16b1-1931 R1952 | Cast-iron pipe flanges and flanged fittings (for 800-lb hydraulic pressure) |
| B16b2-1931 R1952 | Cast-iron pipe flanges and flanged fittings (for maximum wsp of 25 lb) |
| B16.1-1948 R1953 | Cast-iron pipe flanges and flanged fittings, class 125 |
| B16.3-1951 R1958 | Malleable-iron screwed fittings, 150 lb |
| B16.4-1949 R1953 | Cast-iron screwed fittings, 125 and 250 lb |
| B16.12-1953 | Cast-iron screwed drainage fittings |
| B36.2-1958 | Welded wrought-iron pipe (ASTM A72-56T, ASME SA-72) |
| B36.10-1959 | Wrought-steel and wrought-iron pipe |
| B36.16-1956 | Spiral-welded steel or iron pipe (ASTM A211-54) |
| B36.23-1959 | Welded and seamless open-hearth iron pipe (ASTM A253-55T) |

## Copper and copper-alloy pipe and fittings

| | |
|---|---|
| B16.15-1958 | Brass or bronze screwed fittings, 125 lb |
| B16.17-1949 R1953 | Brass or bronze screwed fittings, 250 lb |
| B16.18-1950 | Cast-brass solder-joint fittings |
| B16.22-1951 | Wrought copper and bronze solder-joint fittings |
| B16.23-1955 | Cast-brass solder-joint drainage fittings |
| B16.24-1953 | Brass or bronze flanges and flanged fittings |
| B16.26-1958 | Brass fittings for flared copper tubes |
| H26.1-1958 | Seamless copper pipe, standard sizes (ASTM B42-57, ASME SB-43) |

## Miscellaneous standards

| | |
|---|---|
| A13.1-1956 | Scheme for the identification of piping systems |
| B26-1925 R1953 | Fire-hose couplings, screw thread |
| Y32.10-1958 | Graphical symbols for fluid power diagrams |
| Z32.2.3-1949 R1953 | Graphical symbols for pipe fittings, valves and piping |
| Z32.2.6-1950 R1956 | Graphical symbols for heat-power apparatus |

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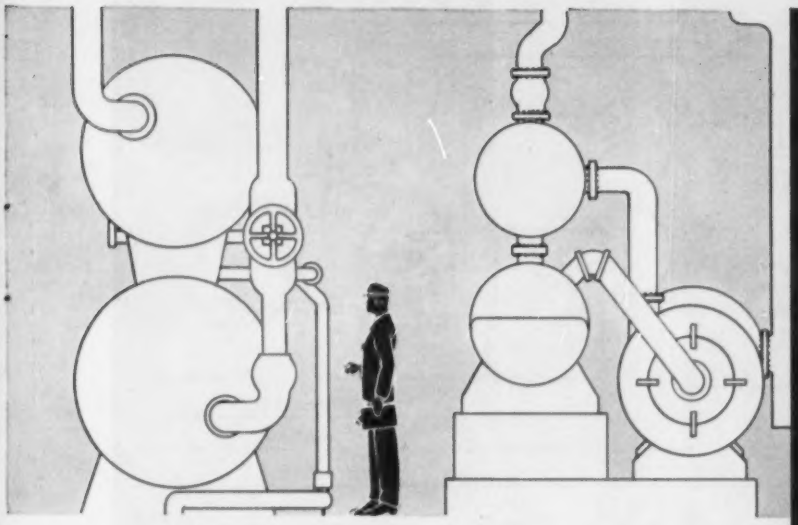
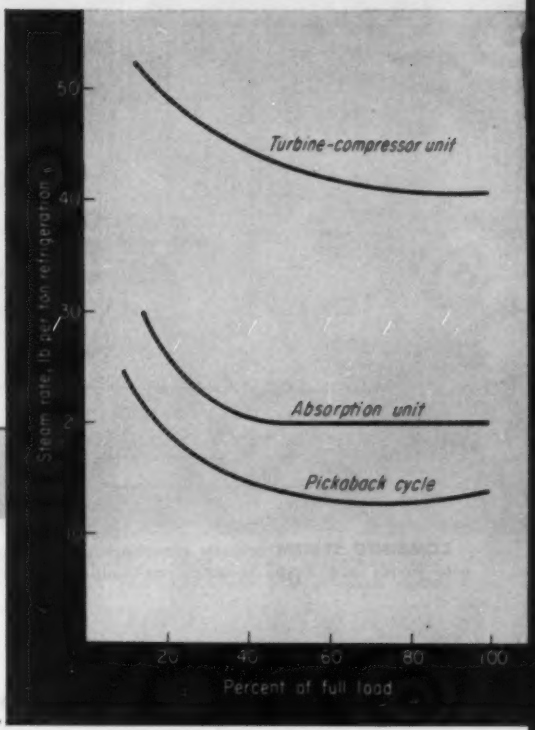





**Space-saving setup also reduced water rate**

Available basement area at Statler Hilton Hotel would not hold two absorption machines of sufficient size to carry hotel's cooling load. Compressor unit in series with absorption system solved their space problem, resulted in improved cycle water rate shown in load curves at right

# Pickaback cooling trims system costs

## Boston's Statler Hilton Hotel installed combined system to solve space problems and cut operating costs to boot

By L E STEWART
Associate Editor

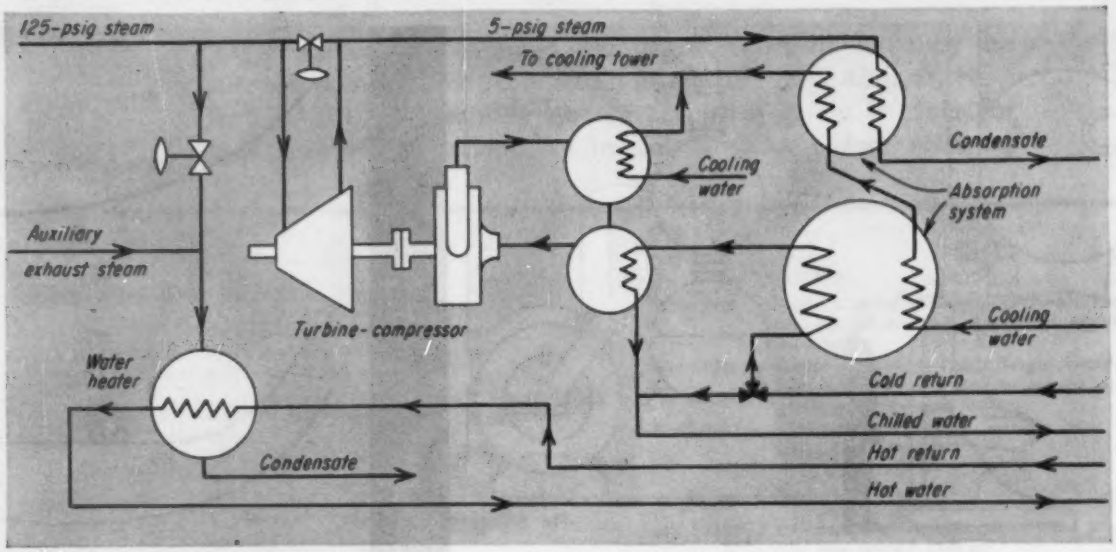
Today many plant and commercial-building owners are faced with the problem of fitting sizable air-conditioning systems into existing buildings. This is no small problem for the designer since selection of the best air-conditioning system for any given installation is usually complicated by lack of space as well as need to integrate into existing plant energy systems. If you are faced with the problem of designing air conditioning for existing buildings, experience at Boston's Statler Hilton Hotel may suggest the perfect approach to your system—a pickaback setup.

**Pickaback refrigeration** system consists of steam-turbine-driven centrifugal compressor operating in series with an absorption machine. Operating from existing 125-psig steam supply, turbine drive exhausts to absorption unit. Recent engineering applications have found turbine exhaust steam quite successful as driving force for absorption systems (for details of one application, see POWER, Nov 1959, pp 59-61). In the Statler Hilton, logical extension of this principal to the combined cycle represents another opportunity to trim operating costs for air conditioning.

**Designers** faced severe space limitations in air conditioning the Boston hotel. Load was over 800 tons and hotel management and the consulting engineers preferred absorption-refrigeration equipment. But largest available absorption system wasn't large enough and there just wasn't room for two. Answer was a combination system, with small turbine-driven compressor tucked in a corner to supplement a reasonably large absorption-refrigeration unit.

Many engineers know that operating savings can result from a combination system, but degree of economy may be surprising. In round figures, an absorption-refrigeration system requires 20 lb of steam per ton-hr of refrigeration. A noncondensing steam-turbine-driven centrifugal compressor needs 40 lb per ton-hr. If the two cycles operate in series, 40 lb of steam per hr produce two tons of refrigeration from the absorption system and, almost free, an additional ton of refrigeration from the turbine-driven system. Overall water rate then becomes 13.3 lb per ton-hr.

Up to this point everything is pretty self-evident. But few engineers have




**COMBINED SYSTEM** operates simultaneous heating and cooling to supply new 3-pipe induction air-conditioning units in each room. H-p steam feeds turbine drive of compressor or, through reducing valves, water heater and absorption-refrigeration unit

## System design makes best use of available steam energy

analyzed the combined cycle for partial loads. To see what can happen, look at water-rate curves on preceding page: at partial loads down to 50%, combined water rate actually improves.

**Improved water rate** was a big bonus in the Hilton system. Watching the system perform, engineers noted that needle on the 0- to 15-psig steam gage in the line between turbine exhaust and absorption system was hard against the zero pin at part load. They substituted a compound pressure gage, and sure enough, system was working with intermediate steam pressure *below* atmospheric. Basic characteristics of the absorption-refrigeration systems produced this situation: within limits of usual cooling-water temperatures, absorption unit's minimum required steam temperature corresponds to a vacuum condition. Since condensing efficiency improves as load decreases, part-load steam pressure approaches minimum value. The two characteristics combine, reduce turbine-exhaust pressures below full load.

Since water rate for a steam turbine is affected more by backpressure than by supply pressure, partial-load water rate of the turbine, when included in turbine-absorption cycle, is better than full-load rate. Absorption-system water rate remains constant down to about half load, so turbine governs shape of the water-rate curve for the pickaback cycle.

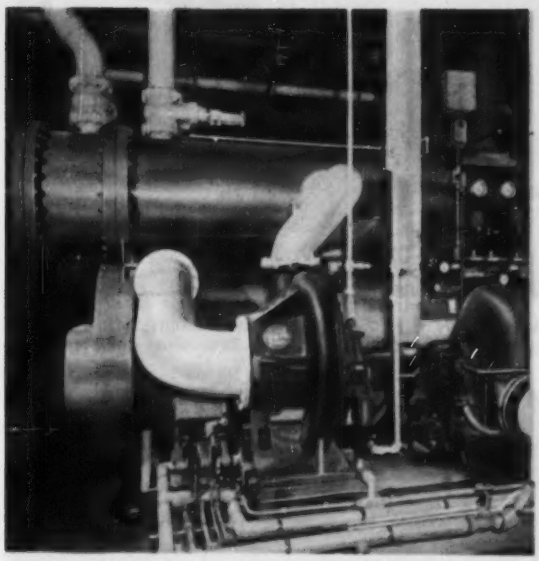
Water-rate curves on preceding page won't hold for all pickaback systems. Turbine throttle conditions as well as cooling-water temperature modify basic relationship between the two rates. But as a rough approximation, combination system is a natural for loads of 300 tons and up wherever available high-pressure steam supply makes a turbine drive attractive—say 100 psig or above.

**System design** for the Statler Hilton took into account tight space all around plus available 125-psig steam supply. Existing boiler capacity could handle the air-conditioning load, and compressor-absorption team would just fit in basement space. Turbine-compressor and absorption units were sized on relative water rates. On a per-pound basis, absorption unit supplies approximately twice as much cooling as turbine unit. By equating water flows, a pickaback system will divide cooling load, two-thirds to absorption cycle and one-third to compression cycle. At part loads this relationship is modified somewhat by drop in turbine water rate.

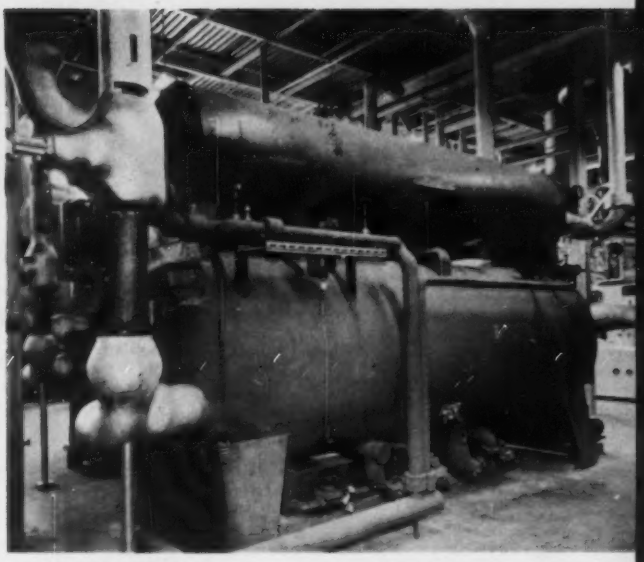
**Low-load operation** involves straight absorption cooling. Turbine compressor drops out of service, absorption system receives steam through a turbine-bypass reducing valve. Bypass line also permits system operation at two-thirds full load while turbine is down for maintenance or inspection.

**System diagram,** above left, shows combined heating and cooling cycle of new 3-pipe induction air-conditioning system. As far as refrigeration equipment is concerned, system is a 4-pipe circuit with separate hot and cold return lines. Cold return splits before entering absorption machine. Bypassed portion mixes with chilled water from the refrigeration cycle to produce desired supply temperature for induction units.

Warm return water passes through a heat exchanger supplied with l-p steam from either a reducing-valve station teed off the 125-psig line or a l-p exhaust line fed by steam-driven auxiliaries in the building. Circulating pumps for hot and chilled water are located on hotel's third floor; guest and sample rooms served by the system run from the fourth to 14th



**TURBOCOMPRESSOR** supplies one-third refrigeration load in compact unit. Compressor drops out as load falls below half



**ABSORPTION SYSTEM** carries major part of refrigeration load. Largest obtainable unit just shoehorned into available space

## Basic refrigeration design data

| | |
|---|---|
| **Heating load** | 7,714,000 Btu per hr |
| **Converter** | 900 gpm of water from 115 to 140 F, steam at 10 psig. Capacity, 11,300,000 Btu per hr |
| **Preheat coils** | Glycol filled, to heat 71,393 cfm from 0 to 50 F. Capacity, 3,860,000 Btu per hr |
| **Primary air systems** | Capacity of east system, 34,395 cfm; west system, 37,198 cfm; total, 71,593 cfm |
| **Absorption system** | Capacity, 574 tons; chilled-water flow, 1725 gpm cooled from 53.3 to 45.3 F. Condenser-water flow, 1800 gpm; rise, 85 to 106 F |
| **Compression system** | Capacity, 238 tons; chilled-water flow, 1725 gpm cooled from 45.3 to 42 F. Condenser water flow, 714 gpm; rise, 85 to 95 F |
| **Refrigeration systems** | Engineered and manufactured by York Corp, subsidiary of Borg-Warner Corp |
| **Consulting engineers** | Jaros, Baum and Bolles |

floors. Installation of the room-air-conditioning units is in progress, with construction occurring in small blocks of rooms to minimize upset in hotel service. When completed, system will handle heating and cooling for some 1300 individual rooms.

Condensing cooling water circulates through both units in parallel, then through a roof-mounted cooling tower. Total flow runs about 2500 gpm with turbine compressor and absorption units operating in series.

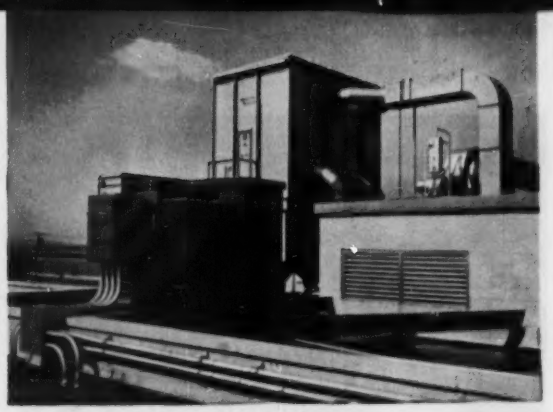
**Design figures** for the basic refrigeration system appear above. Most-important item from designer's standpoint are relative water rates, operating costs and installation costs for the system. In this particular case we're talking about a hotel, but the basic pickaback-system principal applies equally to an industrial installation. Wherever steam pressure is 100 psig or better, the pickaback cycle is possible. Where steam generators are already on the line supplying process or other needs, incremental operating cost merely consists of fuel plus auxiliary power. Under these conditions, pickaback cycle becomes an economically attractive means of generating large quantities of refrigeration with steam power.

Future development of pickaback cycles may see even greater improvements in part-load cycle water rates. New control techniques promising improved low-load water rates for absorption systems may prove a boon. (For more on absorption-system control, look for POWER's coming article on control systems for basic refrigeration cycles.)

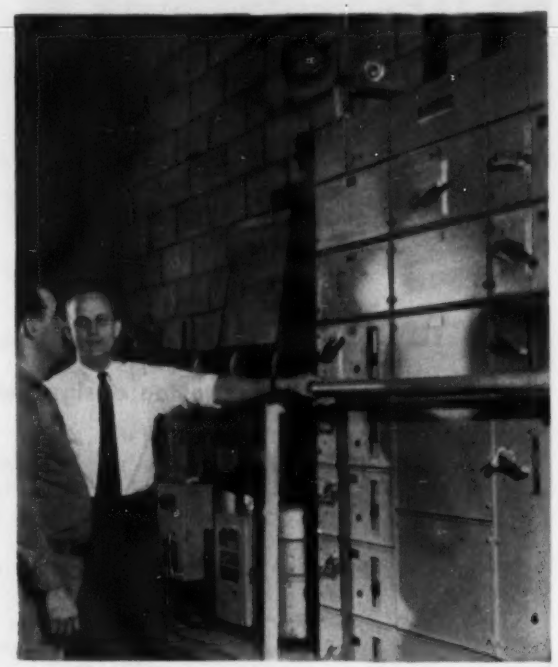
**Your own system** requirements may point toward pickaback refrigeration. A final evaluation of cycle cost requires close cooperation between equipment manufacturers and your consultants; selection of turbine components is not yet an off-the-shelf operation. Manufacturers can take system requirements, design a balanced system and then supply you with water-rate curves and relative-cost figures. Just this sort of cooperative effort between manufacturer, consultant and management of the Statler Hilton resulted in a topnotch solution to their air-conditioning problems, and a cut in operating costs.

**Power to grow ...electrically**

NO. 21: PLANT CONSOLIDATION



**SUBSTATION** rated 750 kva, 4160 to 480 volts mounts on roof, supplies motor-control centers below. Dust collector shows at back



**MOTOR-CONTROL CENTERS** include plenty of spare compartments for future loads. Battery chargers for trucks are at left

Leading ink manufacturer, consolidating operations in new plant, finds that . . .

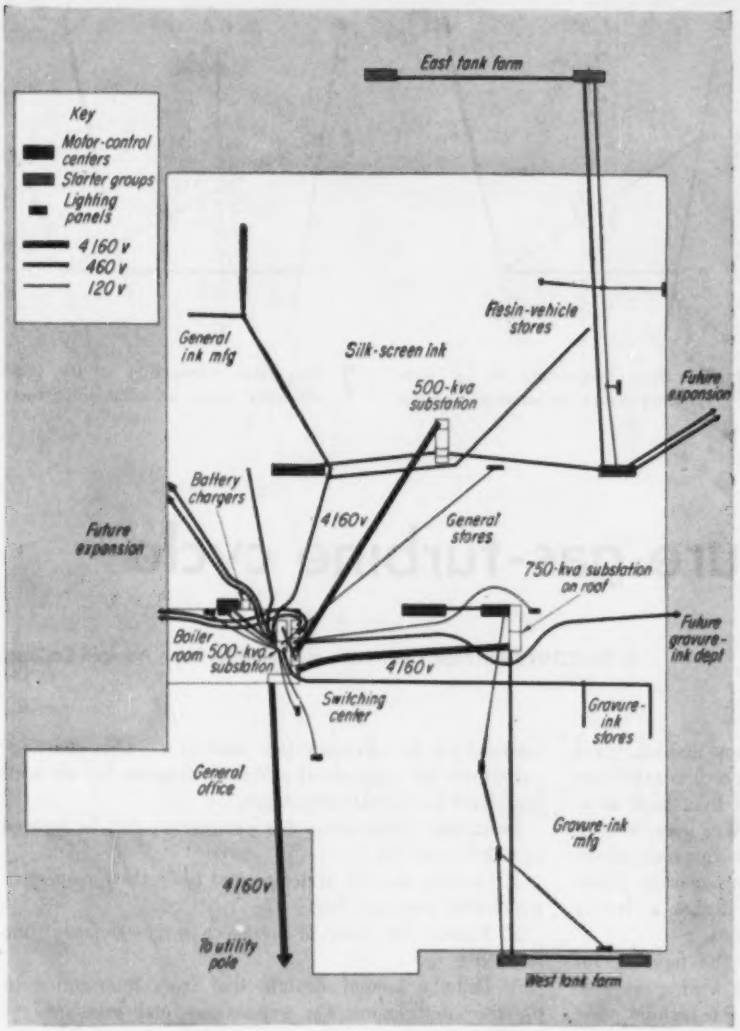
# PTG planning pays off from the start

**P**ower to grow . . . *electrically* was high on the priority list when management of Sinclair and Valentine Co, Div of American-Marietta Company, decided to build a new plant at Secaucus, N. J. Plant produces inks, varnishes and related products for printing, combining some operations formerly conducted at other plants. Electrical-distribution system was designed to facilitate moving these operations with minimum production disruption, and to provide for long-range expansion of production and storage capacity. Abbott, Merkt & Company were overall consulting engineers for the job.

**Energy** is purchased at 4160 v from Public Service Electric and Gas Co. Three 350-MCM 1-conductor rubber-insulated neoprene-jacketed cables run in 4-in. conduit underground from power company's pole at edge of plant property to a primary switching center above boiler room. From primary switching center, power feeds radially to three unit substations: 500 kva in boiler room, 750 kva on a roof location and 500 kva in a production area, sketch at right. Secondary distribution at 460 v feeds motor-control centers within the building and motor-starter groups in two tank farms outside. Lighting panels and some single-phase motors are supplied by 120-v lines.

Forty years of growth in their New York City plant taught company's staff importance of designing so power for expanding production is available without major revisions in the electrical-distribution system. Electrical installation at the new plant was planned for five "work phases": (1) complete installation of a motor with its controls (2) complete installation except for connection to motor (3) conduits installed, and starters in motor-control centers, but no wires or pushbuttons (4) installed conduit and space allowed in motor-control centers (5) space in control centers only, without conduit or wiring.

**Work phases** (1), (2) and (3) provided smooth transfer of production machinery from other plants, allowing for overhaul, and addition of




**PLANT LAYOUT** shows existing circuits and conduit runs for future expansion. Radial scheme starts with switching center, goes to substations, control centers, lighting panels

**VAPOR ANALYZER** continuously samples air rotating between four stations in plant

new machines. Move started in September, plant began full operation in December 1959.

Long-range PTG involves work phases (4) and (5). About 20% of conduit installed was intended to take care of future loads. Space was provided for additional switchgear, with ample compartments for additional starters included in motor-control centers. PTG thinking extended to other areas, too. Examples: extra tanks were installed in tank farm where varnishes and other volatile materials are stored. Land includes five extra acres for future expansion.

Switching center, located above boiler room, contains metal-enclosed fused load-break switches for distribution of 4160-v power. Switch in incoming line has provision for two 400-amp fuses in parallel; one is now installed. Three fused switches connect feeders to existing substations. Three additional switches can be added; then a second 400-amp incoming fuse will be installed.

**Transformer windings** are connected delta-wye with secondary neutrals grounded. Present load on 750-kva transformer is about 450 kva, boiler-room 500-kva unit carries nearly full load and third sub presently handles 350 kva. Total plant load today is 1250 kva.

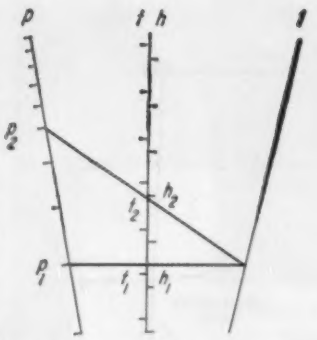
**Control-center** feeders are protected with air-magnetic circuit breakers. Starters are across-the-line type. Motor sizes range from a 60-hp ball mill to numerous units in 1-to-10 hp group. Control-circuit voltage for all starters is 120-v ac.

Manufacture of modern printing inks results in a variety of vapors which may be explosive, toxic or both. In the Secaucus plant, motor-control centers are located outside hazardous-vapor areas so explosionproof enclosures won't be needed. An automatic vapor-detection system prevents accumulation of dangerous concentrations: air is continuously sampled at several plant locations and automatically transmitted to testing equipment in lab where it is analyzed. An instrument indicates concentration and sets off an alarm when concentration increases above a safe value. Some processes continue automatically after normal working hours without supervision, so vapor detection is on a 24-hr basis; when operating personnel aren't present alarm is registered through the ADT system.

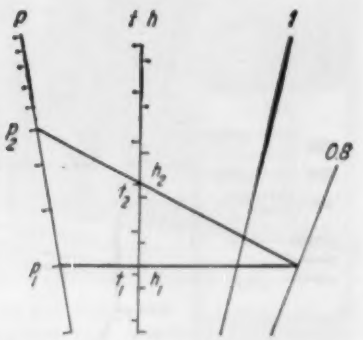
Some vapors can't be released to the outside atmosphere without possibility of objectionable air pollution. A catalytic combustion unit installed in the exhaust stack licks this problem by completely consuming vapors.

**Steam plant** has three gas-fired Scotch marine boilers, each 2500 lb per hr. Operation is completely automatic. Steam is used for ink and varnish production as well as for heating building. Outside temperature is figured in by electronic control.

**Energy-systems engineering has great need for finding faster ways of getting its mathematical work done. Here's an original contribution to speedily choosing the right gas-turbine cycle for any given application. Charts calculate and record all studies of alternate cycles**




1 Two lines intersecting on 1.0 stage efficiency figure an isentropic process




2 Two lines intersecting on 0.8 stage efficiency figure an adiabatic process

# Four lines figure gas-turbine cycle

By Dr JOHN KREITNER, Chairman, Mathematics Dept, Adelphi College

Using gas turbines in new fields means making many calculations before choosing a cycle. Speed, convenience and graphic clarity are more important than *high* accuracy when comparing alternatives. We may assume working fluid to be dry air since thermodynamic effects of water vapor and combustion products usually cancel out. For higher accuracy we usually figure a dry-air cycle, apply moisture and fuel corrections.

**Nomogram** on facing page speeds the figuring for compressing and expanding dry air over a wide range of pressures and temperatures. A simple gas-turbine cycle can be computed and recorded on it by drawing four straight lines. More advanced cycles with intercooling and reheating need additional lines. But regardless of cycle the lines drawn calculate and record: inlet temperature and pressure, compressor efficiency, first-stage compression ratio, compressor outlet pressure and temperature, degree of intercooling, intercooler pressure drop, second-stage end pressure and temperature, total indicated compression work per lb of air, pressure drop during heating, turbine inlet temperature, efficiency, expansion ratio, exhaust temperature, indicated expansion work per lb of air, and pressure drop from turbine outlet to stack.

Automatic record on individual charts proves as valuable as the easy graphic calculation. Lines on chart avoid recording or tabulating data on schematic cycle diagrams. Experience shows that arrangement of lines reveals essential characteristics of a cycle.

**Chart scales.** The chart centers on two straight scales, one for pressure and the other for temperature and its corresponding enthalpy. Any straight line drawn across the chart defines a unique thermodynamic state of dry air.

Two lines represent two states, ($p_1$, $t_1$) and ($p_2$, $t_2$). If the two states have the same entropy, their lines will intersect on an *efficiency line* marked *1*. This chart incorporates the relations of a Mollier diagram for air with important additional advantages.

Isentropic compression (or expansion) can be figured as follows, see Fig. 1:

1. Connect starting states $p_1$ and $t_1$ on their respective scales with a straight line
2. Extend the line to intersect *stage-efficiency* line marked *1*
3. Draw a second straight line from intersection to $p_2$, the compression (or expansion) end pressure
4. At intersection with center scale read $t_2$ and $h_2$
5. Difference $h_2$–$h_1$ is the isentropic compression (or expansion) work

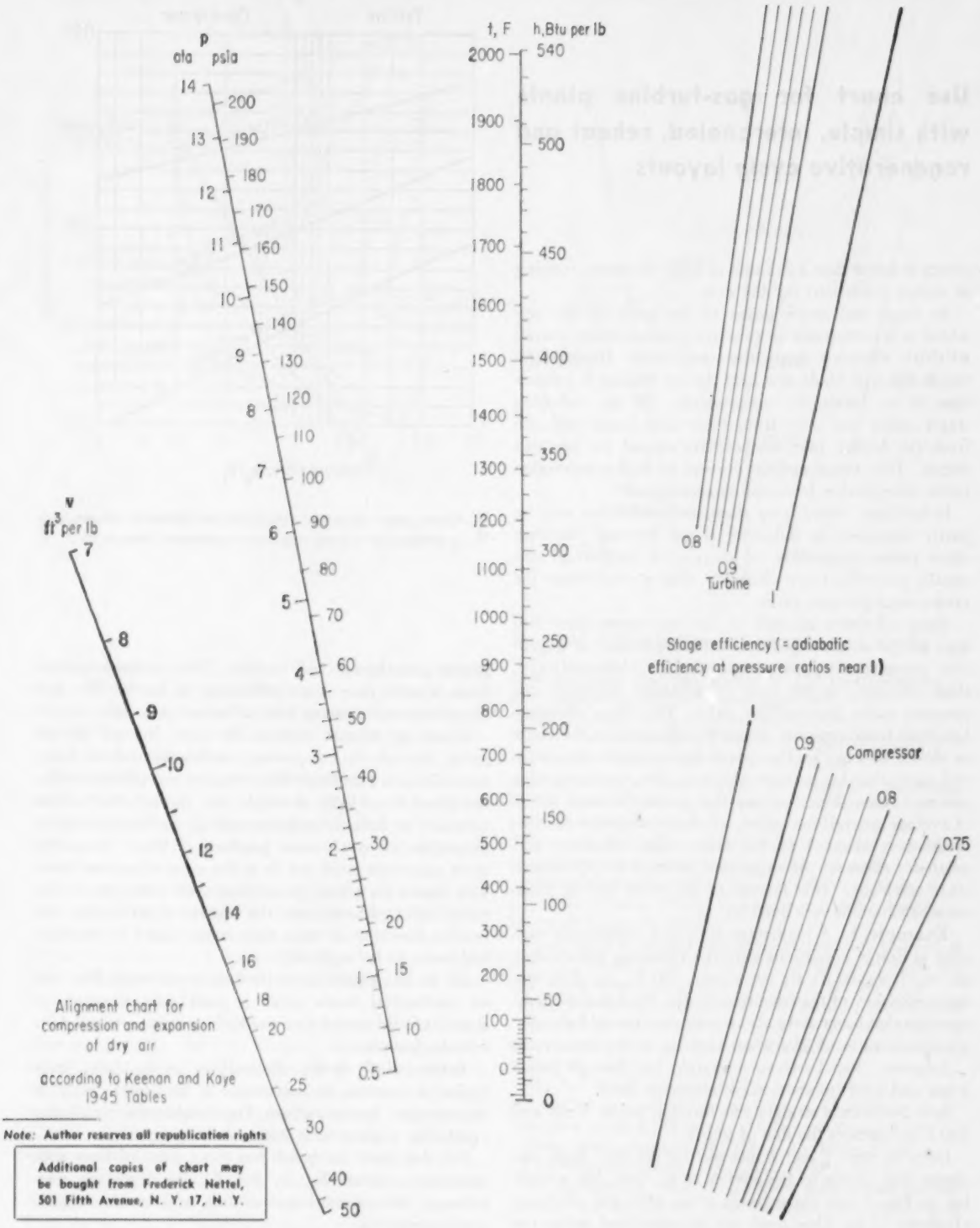
Difference can be found as easily on a Mollier diagram for air. But our nomogram goes one step farther by including a family of curves for stage efficiency. At upper part of chart the curves apply to expansion, at lower part to compression efficiency.

To use this feature, Fig. 2, extend the state line $p_1$, $t_1$ to intersect the stage efficiency, say 0.8 for 80%. Then connect intersection to the end pressure $p_2$ and read $t_2$ and $h_2$ from the center scale. "Indicated" compression work per lb of air then equals $h_2$–$h_1$. "Indicated" work means it is less than total work input by the amount of mechanical losses.

**Accuracy.** Relation between pressure and temperature scales is mathematically exact; results are accurate to the degree of care taken in reproducing the chart, drawing lines and reading scales. When intersections do not slant too much, enthalpy can be read to about ± 1 Btu per lb of air.

Specific-volume scale, $v$, at left is read by drawing a state line to intersect it. This scale gives answers to within ± 2 or 3%. Accuracy depends on variation of

## Nomogram for air compression and expansion speeds cycle calculations

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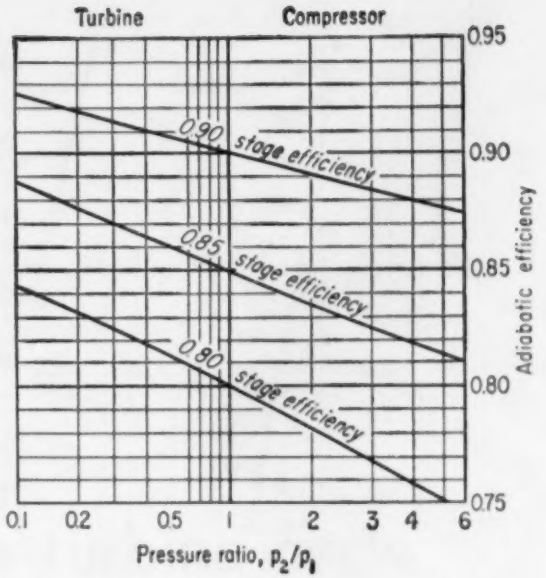
Additional copies of chart may be bought from Frederick Nettel, 501 Fifth Avenue, N. Y. 17, N. Y.

actual specific heat of air with its own temperature.

**Efficiency.** Quality of a turbine or compressor may be expressed by its *indicated adiabatic efficiency*. This is ratio of actual enthalpy difference to that of an isentropic process for the same pressure ratio. This quality measure holds only for machines of similar size and pressure ratio when making comparisons. If pressure ratios differ substantially, adiabatic efficiency reflects difference in pressure ratio as well as equipment quality. For example, a 4:1 compressor with 83% adiabatic effi-

## Use chart for gas-turbine plants with simple, intercooled, reheat and regenerative cycle layouts




**3** Given stage efficiency yields higher adiabatic efficiency in a turbine but a lower one in a compressor, depends on $p_2/p_1$

ciency is *better* than a 2:1 unit of 84% efficiency, running at design conditions for the unit.

As more and more stages of the same quality are added in a compressor to raise the pressure ratio, overall adiabatic efficiency drops lower and lower. Irreversibilities in the first blade row heat the air making it warmer than in an isentropic compression. All the following stages suffer not only from their own losses but also from the higher inlet temperature caused by previous stages. This compounding process in high-compression ratios often makes intercooling economical.

In turbines, losses from stage irreversibilities may be partly recovered in following stages because reheating effect raises availability of energy. A multistage unit usually performs more efficiently than a single-stage for same overall pressure ratio.

*Stage efficiency* as used in the nomogram gives end state of the air directly for either compression or expansion processes for any pressure ratio. Mathematically, stage efficiency is the limit of adiabatic efficiency for pressure ratios approaching unity. This stage efficiency has been translated into adiabatic efficiency in the chart as shown in Fig. 3. This gives an automatic allowance and correction for number of stages that must vary with pressure ratio. Fig. 3 shows that in the pressure ratios of average gas-turbine cycles, adiabatic efficiency of compression is about 3 to 4% below stage efficiency and adiabatic efficiency of expansion about 2 to 3% above stage efficiency. This feature of the chart lets us make some calculations very quickly:

**Example 1.** A multistage axial-flow compressor running at design conditions gave the following test results: air in—1 ata, 80 F; air out—5 ata, 500 F. (*a*) Find the stage efficiency of the compressor. (*b*) Find the end temperature that fewer rows of the compressor would give for a pressure ratio of 2½ when running at the same rpm.

*Solution:* Step 1—Draw a straight line through points 1 ata and 80 F to cross stage efficiency lines.

Step 2—Draw a straight line through points 5 ata and 500 F to intersect the line of step 1.

Lines of steps 1 and 2 intersect on the 0.80 stage efficiency line, giving us the answer to *a*. Note that according to Fig. 3 this corresponds to an adiabatic efficiency of about 75%. This need not be calculated using the chart, but would have to be if we used a Mollier diagram.

For the answer to *b*, draw a straight line from the intersection on the 0.8 stage efficiency line to 2½ ata on the pressure scale. Find the answer at intersection on the temperature scale of 300 F.

Example, facing page, shows how nomogram may be used for analysis of a gas-turbine cycle with just a compressor, combustor and turbine. More refined calculations usually show little difference in result. We find the various refinements tend to cancel each other.

There are several reasons for this. Not all the air going through the compressor reaches the turbine inlet; some 2 to 3% branches off for cooling and other services. But about 1 to 1½% of weight flow through the turbine comes in as fuel. In addition, change in thermodynamic properties of combustion products delivers 2 to 4% more expansion work per lb at the same expansion ratio. This leaves the actual gas-turbine cycle with just a little more indicated work than the equivalent air cycle. Difference, however, is more than compensated by mechanical losses, so far neglected.

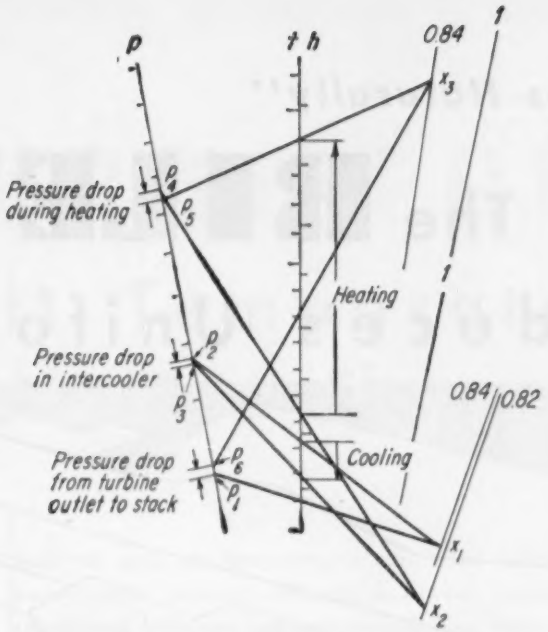
All in all, a pure air cycle with equal mass flow and no mechanical losses gives a good approximation of actual internal-combustion gas-turbine cycles with all their realistic features.

**Intercooled cycle.** Gas-turbine cycles have their typical nomogram arrangements, as for simple cycle in the example. In comparison, Fig. 4 shows the cycle nomogram for a plant with intercooled compression.

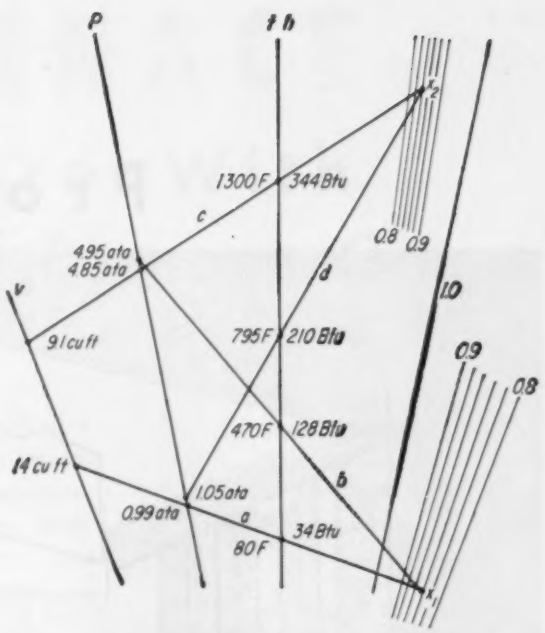
For this plant the graph has three pairs of lines with intersection points $X_1$, $X_2$ and $X_3$, for first-stage compression, second-stage compression and turbine expansion, respectively.

A cycle nomogram has a continuous sequence of lines returning to the starting point. Graph shows the pressure drops clearly in the proper places and their respective amounts. In Fig. 4 the polygon for the intercooled cycle is $p_1$-$X_1$-$p_2$-$p_3$-$X_2$-$p_4$-$p_5$-$X_3$-$p_6$-$p_1$.

Nomogram shows visually the effects of pressure drops and differences in machine efficiency on overall result.




**4** Intercooled gas-turbine cycle has extra pair of lines for second stage of compression and takes account of pressure drops




## Sample calculation of simple g-t cycle

*Compressor:* inlet conditions, pressure = 0.99 ata, temperature = 80 F; stage efficiency = 0.84; compression ratio = 5:1

*Combustor:* pressure drop during heating = 0.1 ata

*Turbine:* inlet temperature = 1300 F, stage efficiency = 0.84, pressure drop from turbine outlet to stack = 0.05 ata

**Solution of cycle.** Draw straight line *a* from 0.99 ata through 80 F to intersect 0.84 stage efficiency at $X_1$. Read $h_1$ = 34 Btu per lb off enthalpy scale

Connect $X_1$ with 0.99 × 5 = 4.95 ata with line *b* and read air temperature leaving = 470 F and $h_2$ = 128 Btu per lb

*Indicated compression work* = $h_2$-$h_1$ = 128 – 34 = 94 Btu per lb

Draw line *c* through 4.95–0.1 = 4.85 ata and 1300 F. Read $h_3$ = 344 Btu per lb opposite 1300 F

Extend line *c* to intersect with 0.84 expansion stage efficiency at point $X_2$. Connect $X_2$ by line *d* to 1.00 + 0.05 = 1.05 ata and read air-out temperature = 795 F and $h_4$ = 210 Btu per lb

*Indicated expansion work* = $h_3$-$h_4$ = 344–210 = 134 Btu per lb

Find flow volume at compressor intake by extending line *a* to intersect *v* scale and read 14 cu ft per lb (accurate value = 13.75 cu ft per lb)

Find flow volume at turbine inlet by extending line *c* to *v* scale and read 9.1 cu ft per lb (accurate value = 9.1 cu ft per lb)

*Net work* = ($h_3$-$h_4$)–($h_2$-$h_1$) = 134–94 = 40 Btu per lb air

*Energy input* = $h_3$-$h_2$ = 344–128 = 216 Btu per lb air

*Cycle thermal efficiency* = 40/216 = 0.185 or 18.5%

If a regenerator is added to the cycle it works between the temperature levels of compressor outlet and turbine inlet, 470 to 795 F. For 70%-effective regeneration the air leaves at 470 + 0.7 (795–470) = 697 F with 185 Btu per lb

*Regenerative-cycle heat input* = 344–185 = 159 Btu per lb

*Regenerative-cycle efficiency* = 40/159 = 0.252 or 25.2%

By inspection of the figure we can estimate how many Btu per lb would be gained if it were possible to reduce pressure drop during heating in heat exchanger and combustion chamber by one-half, or to improve turbine efficiency by one point, etc.

**Readability.** Nomograms have one drawback—some intersections are so slanting that they impair reading accuracy. To remedy these cases, we can work on different parts of the scales to get more nearly perpendicular intersections.

Compression from 1 to 4 ata causes the same temperature and enthalpy change as a compression from ½ to 2 ata. Try it on the nomogram to see how it works. Lay off an initial state at 1 ata and 80 F and let it intersect with 0.84 stage efficiency. Next lay off the final state from this intersection to 4 ata.

To improve reading accuracy, try laying off the initial state as ½ ata and 80 F to intersect with 0.84 stage efficiency. Next lay off the final state from this intersection to 2 ata. You will find that the intersections coincide with the ones first laid on the temperature-enthalpy scale. The more nearly perpendicular intersections make answers easier to read.

To aid this improved-reading trick, the pressure scale has been extended up to 14 ata and down to ½ ata. To keep the nomogram from growing too wide, volume scale has been stopped at 7 cu ft per lb. If you want to find specific volume at 500 F and 6 ata, the state line does not intersect *v* scale. But remembering that $PV = RT$ you can simply halve the pressure. You'll find that the state line from 500 F to 3 ata does intersect the *v* scale at 8 cu ft per lb. So we multiply by 3/6 to find v = 4 cu ft per lb at 6 ata, the answer we seek.

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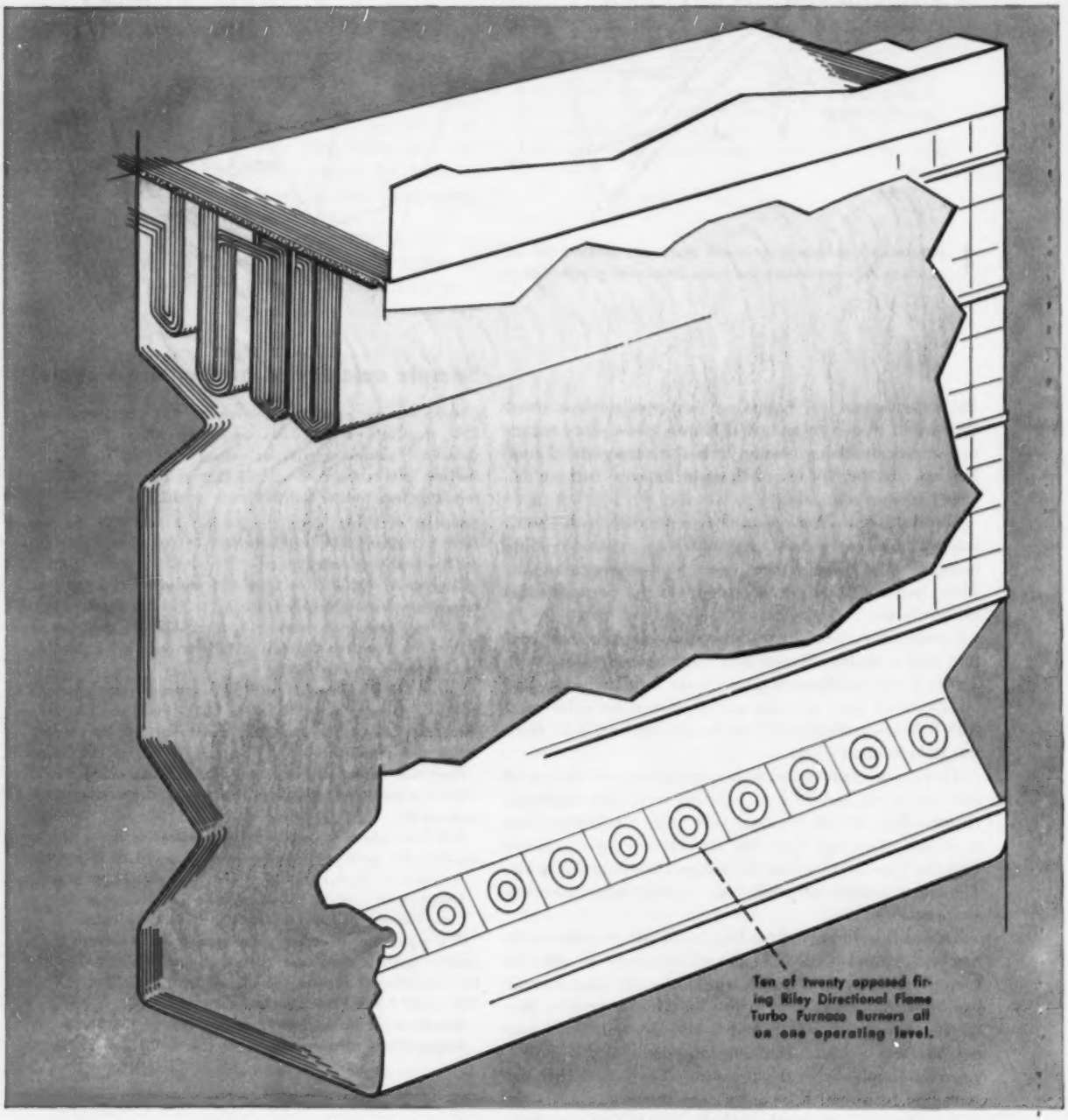


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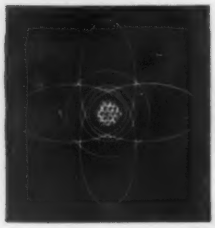


# Nuclear notes

By B G A SKROTZKI, Associate Editor

**World's largest nuclear plant** has been projected by Southern California Edison Company by sending letters of intent to Westinghouse Electric Corporation and Bechtel Corporation. These letters start negotiations between the three parties to build a 360-mwe pressurized-water power plant. The $70-million plant is expected to be competitive with conventional plants over its lifetime. Construction may start next year and take four years to complete. Plant would be fueled with uranium oxide, pressurized to 2000 psig.

**Dresden Nuclear Power Station** of the Commonwealth Edison Company went critical on Oct 15, 1959. The 180-mw plant produced 64 mw this April 18. Production will step up gradually during the next few weeks till rated output is reached. General Electric Company, plant builder, is doing the testing and training Commonwealth Edison operators to handle the boiling-water reactor.

**New alloy materials** sought by Atomics International and United States Steel Corp for the AEC may lower capital and operating costs of nuclear plants. Development program will modify chromium-molybdenum steels to increase high-temperature strength and corrosion resistance to liquid sodium. Columbium, titanium and vanadium will be added to the alloys in this research program.

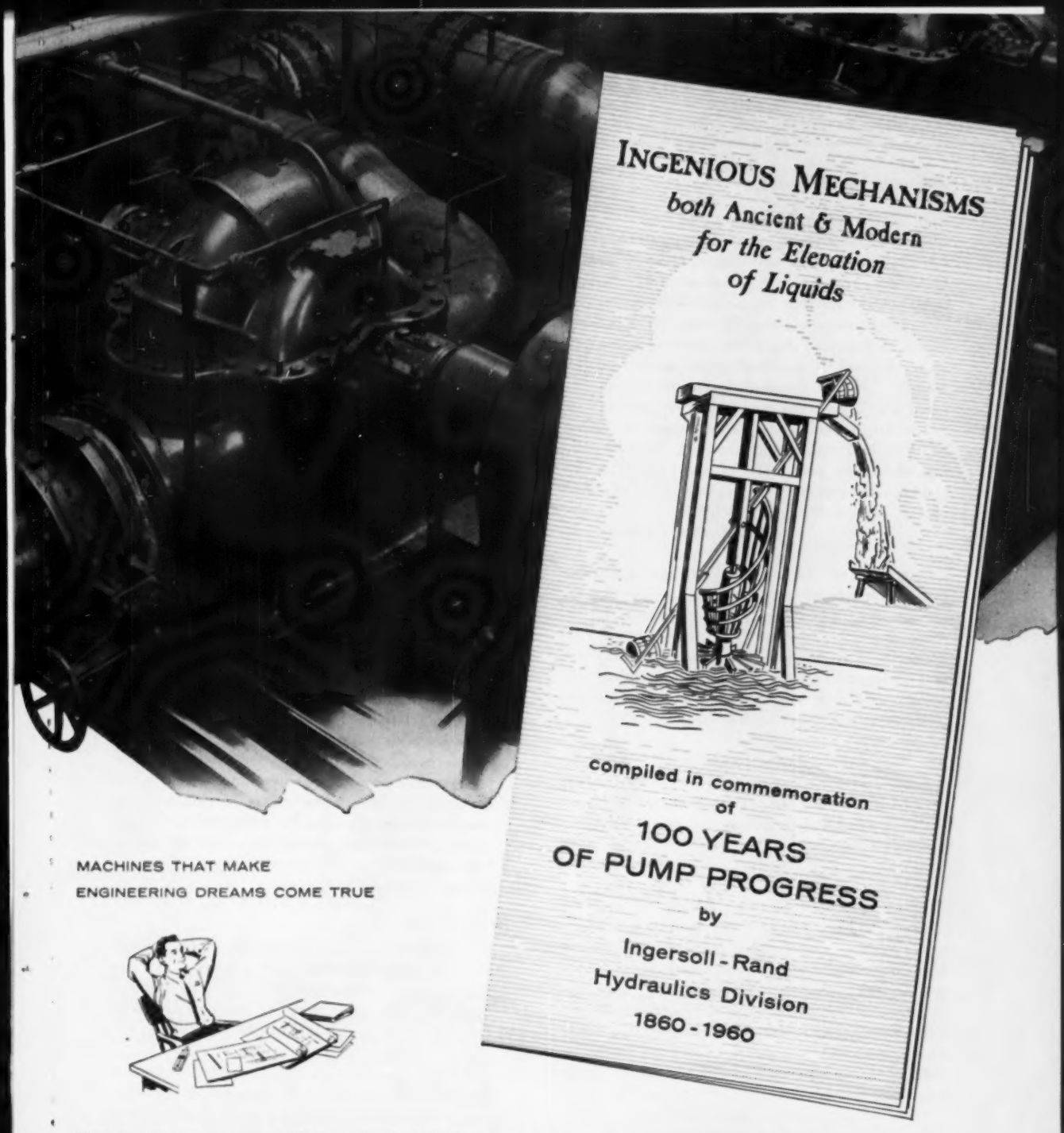
**Experimental Organic Cooled Reactor** (EOCR) at the National Reactor Testing Station, Idaho, will be built by C F Braun and Co of Alhambra, Calif. Fluor Corp is the architect-engineer, Atomics International assists Fluor in nuclear design, Phillips Petroleum Company did the conceptual design. Reactor will cost about $4 million and produce 40 mwt with outlet temperatures about 700 F.

**Isotope power applications,** according to J G Morse of the Martin Company, may include: remote radio beacons and warning devices, fallout and fire warning alarms, meteorological data-gathering units, navigational buoys, probes for deep-sea investigations, subterranean probes for geophysical exploration, telephone repeaters and battery or instrument warning devices.

**AEC's Power Demonstration Reactor Program** offer of building a 22-mwe pressurized-water nuclear-power plant with fossil-fueled superheater has received five proposals. Proposals submitted by Jamestown, N. Y. and Dairyland Power Cooperative, La-Crosse, Wis., met requirements of the invitation, but sites were not fully satisfactory. They have been given two months to propose alternate sites for the new plant.

**Slowdown of nuclear-plant building** in the U.S.S.R. and its satellites has been announced in Red newspapers. Available resources of coal, peat, oil and natural gas make it difficult for nuclear power to compete. U.S.S.R. plans to have 600-mwe capacity in nuclear plants by 1965 *(McGraw-Hill World News)*.

**Gas-cooled nuclear reactor** designed for commercial output of 85 mwe will be engineered by Allis-Chalmers Mfg Co for the AEC. Pressure vessel with 20-ft dia and 45½-ft height will hold over 9000 elements of enriched uranium dioxide. Helium coolant enters reactor core at 510 F and 315 psig, leaves at 1050 F. Gas will produce 1300-psig 900-F steam in two boilers. Two loops fed by reactor each have a steam generator and recirculation blower. Fuel elements can be changed with aid of a charging machine while the reactor carries load.

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# Reserved for your comment

BOB BELLAS, Associate Editor

## Putting waste to work

Your incinerator article was a nice treatment of a subject of concern to many municipalities today (*Available heat from incineration*, May, pp 80-83). While not too many civic governments may be concerned with utilizing incinerator-heat energy for generating power or steam for sale, Mr Meissner's theme of designing for dollar recovery as well as waste disposal is one that gives much food for thought. When it comes to taxpayers' dollars, one saved may often mean more than one earned.

The article mentioned various types of boilers being utilized with incinerator heat, but said nothing about the possibility of an incinerator-gas-turbine combination. Has any research and development been done along this line?

E L HARDESTY, *Chicago, Ill.*

EDITOR'S NOTE: *Author Meissner reports that gas turbines have been considered, to utilize furnace gas through heat exchangers for direct production of power by either the open or closed cycle. This development is believed to be quite remote; there is still much research required to overcome the obvious problems encountered, such as high gas temperature and flyash carryover.*

. . . Nice handling of a rather prosaic, albeit increasingly important subject. One question: article omitted mentioning use of air heaters with incinerators nor did drawings show any such installation. Any significance in this?

DOUGLASS BARKLEY, *Jacksonville, Fla.*

EDITOR'S NOTE: *H G Meissner fielded this one from Reader Barkley, states: "Air heaters have been tried in some installations, but have been found unsatisfactory for several reasons. When refuse is wet and hot air would be desirable, there is insufficient heat in the furnace gas to provide it. On the other hand, when refuse is dry and burns well the heated air tends to raise furnace temperature unduly, so that more excess air must be used to counteract this increase.*

*"Cost of air heaters is quite high, as they must be made of expensive alloys to withstand the high gas temperature involved. If we assume a 2000-F gas and 500-F air preheat, metal temperature will be 1250 F, which is obviously too high for carbon-steel elements. Continued use of air heaters, therefore, seems improbable except when a boiler with waterwalls is included."*

## It's later than you think

The ominous message contained between the lines of George Edwards' article (May, p 206) should not be lost on all who have high-school-age children. Much has been said and written in engineering circles reflecting concern about our educational system's shortcomings. Trouble is, many of our future engineers could come from families of men not now in the profession—*if* these familes could be reached. How to get the message to them is a problem worthy of considerable thought by engineering societies. Typical of current publicity is this excerpt from the Spring 1960 issue of the *Engineer*, published by Engineers Joint Council, Inc. This article may be familiar to POWER readers, but it's well worth repeating the following:

"The United States must decide and take action now to insure the availability of enough engineers and the right kind of engineers to meet the expanding demand for technical services of the 1960's, according to a recently released report by the Engineering Manpower Commission of EJC.

"The report follows the announcement by the U.S. Office of Education that freshman engineering enrollment has declined for the second consecutive year, over 3% in 1959, after an 11% drop in 1958. This, says the Manpower Commission's report, is an unexpected trend when demand for engineers is increasing and is expected to accelerate, especially when the nation is committed to a world contest depending largely upon a sufficient supply of engineering brainpower."

This is, of course, turning the spotlight on our profession's need, and it's becoming an acute one. However, we have slight chance of getting young men and women qualified for undergraduate studies in *any* profession after their native intelligence has been permitted, or perhaps encouraged, to atrophy during their high-school years.

EDWARD R WILSON, *New York, N. Y.*

. . . Good for George. It's about time somebody stood up and pointed the finger at some other cause than parents' indifference for the cerebral underdevelopment of many of our high-school graduates.

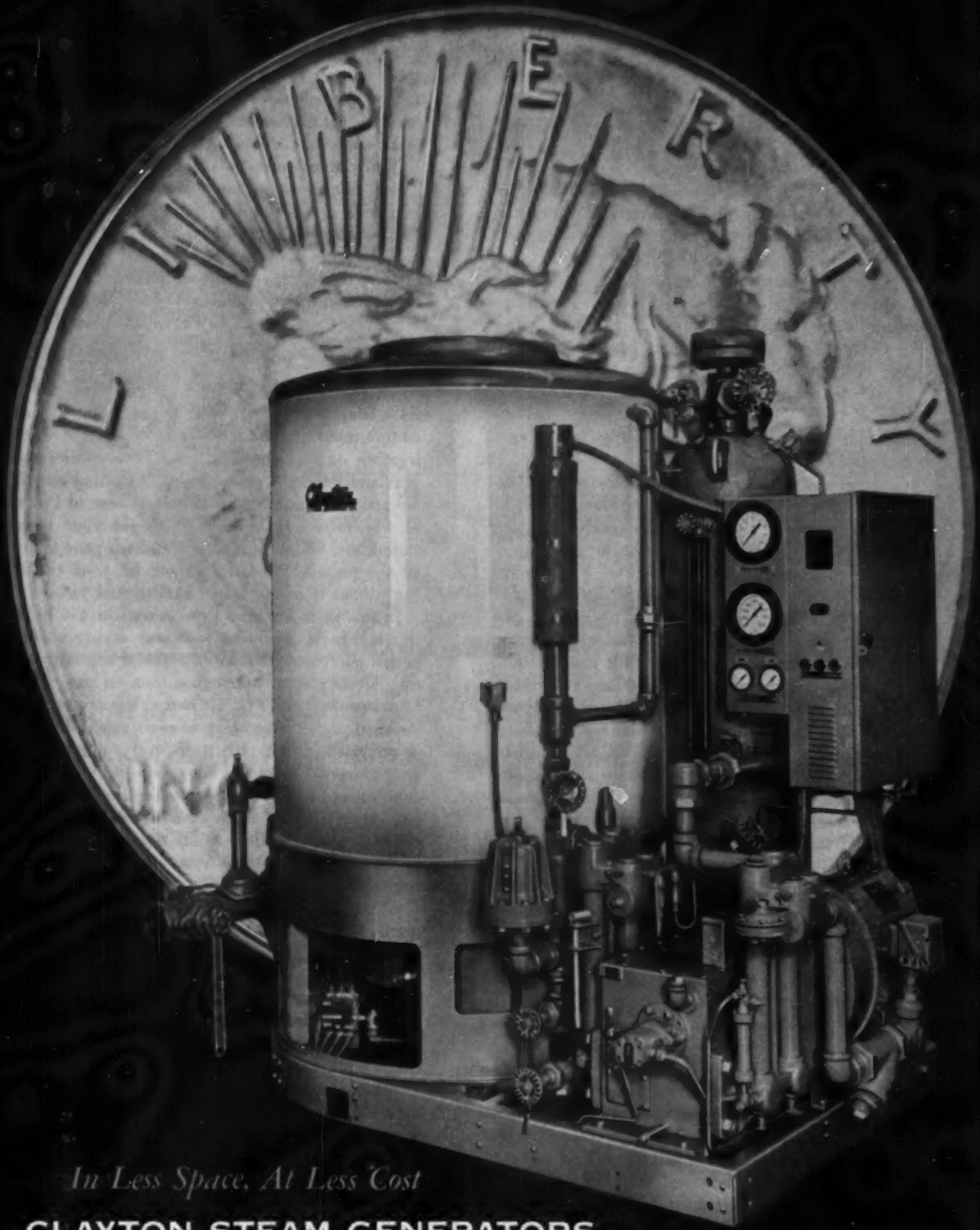
C F LE COMPTE, *Charleston, S. C.*

. . . I always enjoy reading George's articles and this one is no exception. I suspect that his friend Pete is an engineer and wants his boy to follow in his footsteps. Not that he'd be content with the boy's former poor progress, or the high school's contribution to it, whatever profession the boy hoped to enter. But some kids are just naturally cool to science courses, as POWER's news item indicated last year ("High school grads cool on engineering," Feb 1959, p 165).

A lengthy article could be written on this subject, but it can be summarized as follows: Young men of today, reviewing the experience of engineers over the period beginning with the outbreak of World War I in 1914, have noticed that men in overalls have earned more and been better off than

For more facts circle 232 on Reader Service card, p 103 ➤

STEAM THE MODERN WAY

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416 MANUFACTURING COMPANY

EL MONTE, CALIFORNIA • CINCINNATI, OHIO

men who gave up four years of their lives to go through college. When my class graduated in 1915, outlook for engineers was so poor that many immediately selected other lines of work and entirely gave up any idea of following engineering as a career.

H T LIVINGSTON, *Los Angeles, Calif.*

. . . George Edwards has simply restated, in another way, what people in increasing numbers are saying with increasing vehemence. He, and they, are concerned about our educational system's buttermilky approach to a problem that may dump us down the drain if it goes unsolved.

George joins some illustrious company in dealing with this subject. I'd like to quote from a recent speech made in San Francisco by Dr Edward Teller, one of the world's top-ranking physicists and the Director of the University of California Radiation Laboratory at Livermore.

"I believe that the most important factor in deciding what sort of a world we will live in will be the competence of the two groups on this and that side of the Iron Curtain, and the technical competence in particular that all of us will have tomorrow will depend on: Science and Education. I believe that all of us are underestimating the strength and extent of the reforms which are going on in Russia and generally behind the Iron Curtain.

"We have evidence that the Russians are educating about twice as many engineers today as we are. From what I could learn, and I was not in Russia, these engineers are no poorer than us. Further, within the next few years the Russians are planning to increase the number of engineers they will educate per year. We are not planning anything like it, and I think they will carry out their end of the plan. I believe that our educational system is good, but with all that I am convinced that it is not good enough. We all know that the best possible efforts do not come by coercion, but by an inner drive. In Russia and the Iron Curtain countries, people who live quite poorly know very clearly that their hope of a better life is closely connected with their possibility of acquiring an excellent technical education."

On another occasion Dr Teller, who feels very strongly about American lack of knowledge in the fields of science, mathematics and foreign languages, had this to say: "We have very terrible shortcomings in these areas and there could be very sad consequences." He stated that U.S. education is troubled by the inability of many math and science teachers to kindle a spark of interest in students. Too often, he said, teachers are content merely to assign boring exercises and he criticized much of the homework given students as being designed just to keep them busy.

He noticed that his high-school-age son's marks in algebra were slipping. When he asked why, the boy told him that he "didn't do the examples quickly enough." Of this teaching procedure Teller said, "trying to do problems fast under pressure is not mathematics. Elimination of all numerical errors is not mathematics either. Instead of making mathematicians, we're making bookkeepers."

Many of us meet on common ground with Dr Teller as parents of high-school children. When, and only when, we go to the mat with our educational system and *demand* a change in the sort of thing George Edwards and Dr Teller are talking about will we really help our children to prepare for the future they're going to have to live in.

F G WALLACE, *Oakland, Calif.*

## Eureka!

As a long-time POWER reader, I'm aware that the editors wade through technical volumes and wordy treatises on this and that, travel many miles each year and interview many people in coming up with the article material that makes each issue of POWER so worthwhile. I know that one of your proud claims, and rightly so, is that you keep your fingers on the pulse of what's new and let your readers hear about it in quick and easy-to-read fashion.

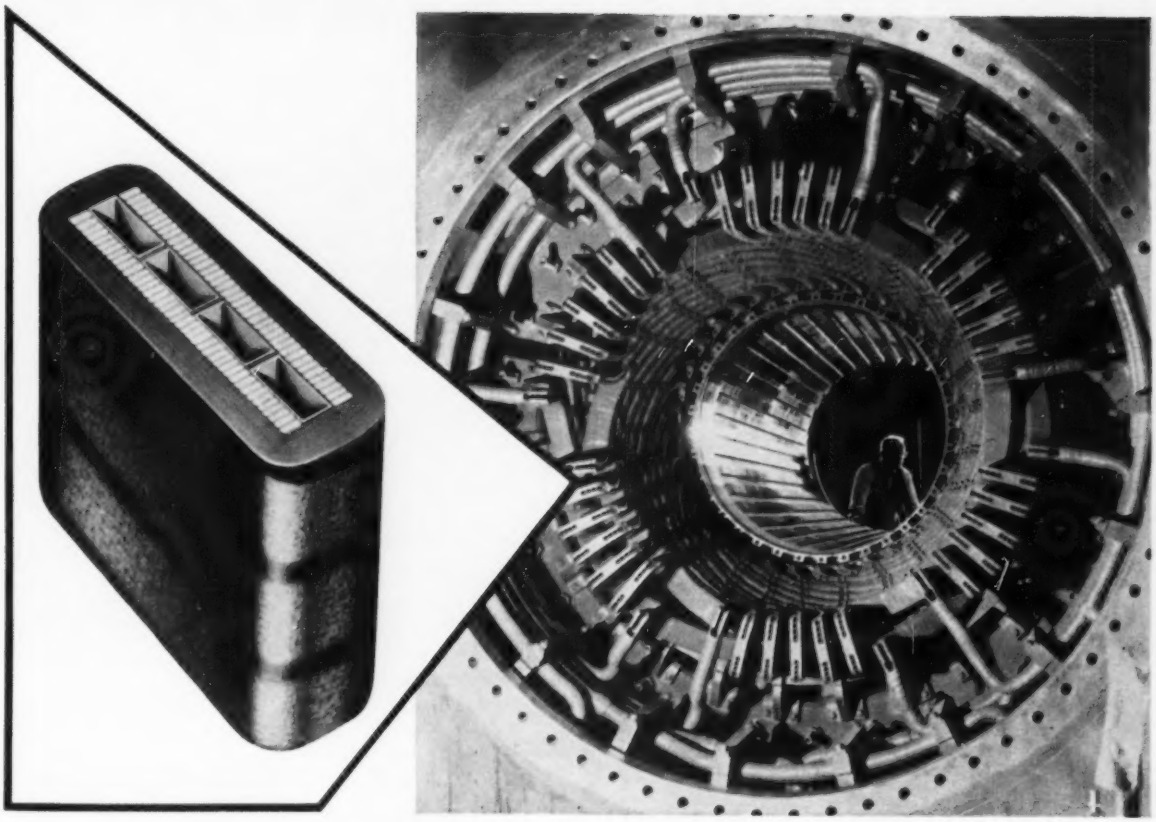
In this vein, I'm sure POWER readers will be interested in a somewhat unusual occurrence experienced recently by a professional engineer who was running some acceptance tests on one of our saturated-steam boilers. He had a steam calorimeter installed and it repeatedly showed superheat from a saturated drum. He tried every double-check and cross-check in the book but the calorimeter continued to show a few degrees of superheat. What had occurred is the result of a curious combination of circumstances. Here is his report, which seems to bear out the adage that sometimes truth is stranger than fiction:

"After careful and considered evaluation of all pertinent data in regard to this seeming phenomenon, the only plausible conclusion to be drawn is that, since a considerably lower solids concentration was present during the final test as compared with results the previous day, this deconcentration of superfluous turbidity transformed the unilateral circulation into bilateral circulation.

"This phenomenon in turn tended to produce neutralization of the effluent with a consequent increase in rectilinear transformation, which promptly converted drooping entropy into rigid enthalpy. As you of course know, increase of rectilinear transformation in the presence of bilateral circulation will, in most cases, produce what is commonly known as ectoplatic emolufication. To put it simply, without this ectoplatic emolufication one will usually wind up with protonic amalgamation, which is generally considered to be detrimental."

J M GUY, *Chief Engineer*
*Erie City Iron Works, Erie, Pa.*

**For more facts circle 233 on Reader Service card, p. 103** ➤
**Circle 234 on Reader Service card for Fisher Governor ad** ➤



# *Carpenter* Stainless Tubing guides hydrogen coolant through giant, fully supercharged generators

Thin-walled, Carpenter stainless tubing ducts (flanked by copper stator coil strands and wrapped in mica tape) circulate hydrogen gas to cool this giant fully-supercharged turbine generator—one of the world's largest power plants.

Carpenter Type 304 rectangular stainless steel tubing was ideal for efficient, conductor cooling design.

(1) It was non-magnetic and prevented excessive heat build-up from a strong alternating magnetic field.

(2) Eddy current losses were reduced by the highly resistant stainless tubing.

(3) The thin-walled but strong Carpenter tubing allowed more room for copper in the stator coil with maximum conductor space inside tubing.

(4) In fabricating stator coils, thin-walled tubing was easier to bend.

(5) Rectangular shape conformed to coil construction and provided maximum heat transfer surface.

Most important, the 6000 ft. of Carpenter stainless tubing used in every generator had already passed the most searching quality control tests applied to stainless tubing anywhere. Dependable performance was assured.

Many types and forms of Carpenter stainless tubing are cutting costs and improving production in power plants all over the country. Call your nearby Carpenter representative for details or write: The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

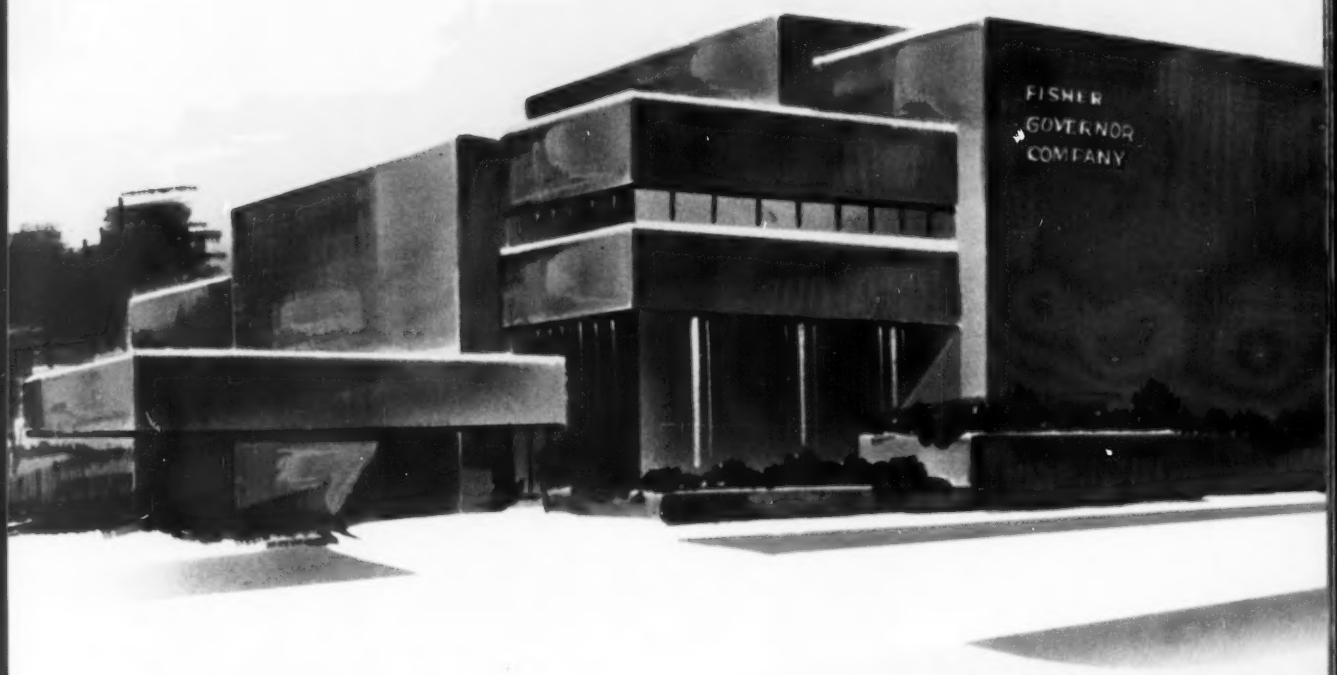
*your master key to cost-savings in power plants*

Carpenter

Steel

**Stainless Tubing & Pipe**

# FISHER .... *an unparalleled*




Standing firmly behind every Fisher product is the "know-how" and motivating spirit that has guided the Fisher organization since 1880. These, combined with the remarkable engineering and manufacturing facilities illustrated and described here, have made possible the slogan: "If it flows through pipe anywhere in the world ... chances are it's controlled by FISHER."

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD ... CHANCES ARE IT'S CONTROLLED BY...

**FISHER GOVERNOR COMPANY**

*Marshalltown, Iowa / Woodstock, Ontario / Rochester, England*

BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIPMENT COMPANY, CORAOPOLIS, PA.

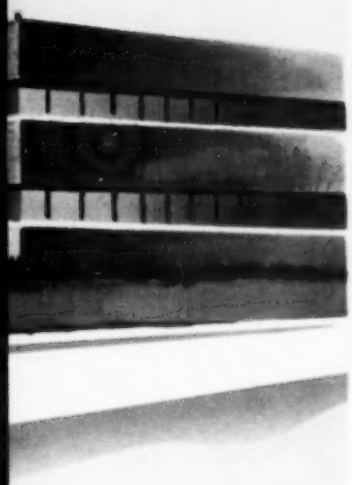
**CONTINUOUS ADVANCED RESEARCH**
Increasingly severe service conditions are encountered daily in the fields of nuclear power and cryogenics. To meet these conditions, Fisher research maintains a continuous program for development and use of new metals and materials.

**PRACTICAL DESIGN ENGINEERING**
Design engineering at Fisher is always aimed at solving industry's flow control problems, practically and efficiently. Over 80 years of development and improvement has resulted in a full line of controls of proven durability and performance.

**TESTING AND DEVELOPMENT**
Representative of the very latest and finest in equipment, that aids Fisher engineers in the development of new and improved products, is the recent addition of a test line that is capable of handling pressures up to 2500 psi, air or water.

# *engineering and manufacturing facility*

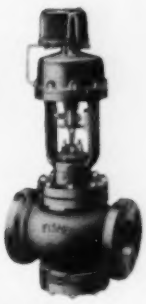
## ....to build better
## PRESSURE AND LIQUID LEVEL CONTROLLERS



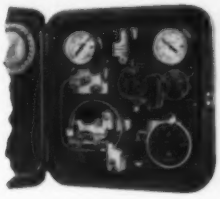
Type 657-A
Diaphragm
Control Valve

Type 2500-249
Level-Trol

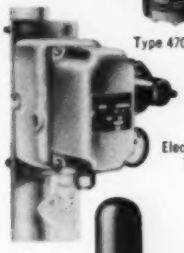
Series S100
Gas Service
Regulator



Type 470 P.O.P.

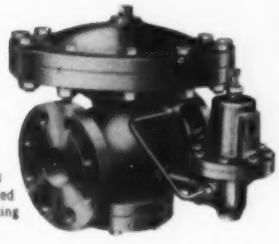


Wizard II
Pressure Controller

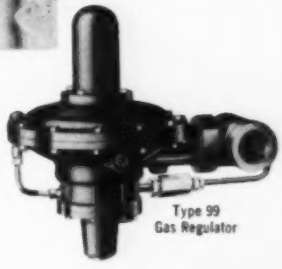


Type 543
Electro-Pneumatic
Transducer

Type 350
Electro-Hydraulic
Control Valve



Type 92-B
Pilot-Operated
Steam Reducing
Valve

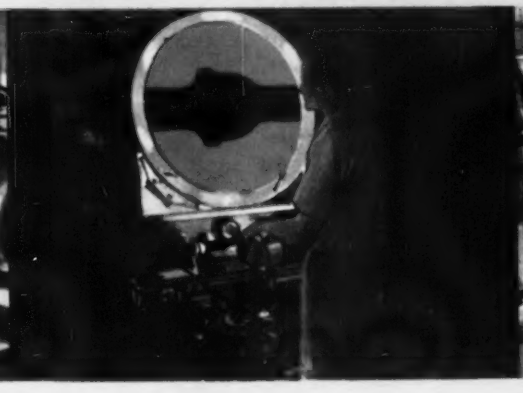


Type 99
Gas Regulator

FISHER® Controls

*SINCE 1880*

**LATEST PRODUCTION METHODS**
Various new style grinders produce a super-finish on Fisher valve guides and bushings, second to none in the industry. It is typical of precision manufacturing methods that assure long, trouble-free operation of Fisher controls in the field.



**RIGID INSPECTION PROCEDURES**
The highest ratio of inspection personnel to production personnel, in the control valve industry, is maintained at Fisher. As a typical example, there are no less than 704 inspection operations performed on a 4" Type 657-A diaphragm motor valve.

**EFFICIENT FIELD SERVICE**
"Supermarket" 36-hour delivery, from the factory, on popular sizes and types of controls is only one of many services available to Fisher customers. 17 sales offices throughout the country maintain field stocks for immediate delivery.

HAGAN NEWSLETTER—JUNE

# Behind the panel

## DATA LOGGER ON WHEELS FOR MULTI-PLANT PETROLEUM CORPORATION

Designed for a major European oil producer, this new departure in data processing will consist of a Series 2000 Kybernetes Data Logger mounted in a trailer. The trailer will not only house the 100-point data system, but will also contain its own regulated power supply equipment, so that only the inputs from process transducers and unregulated plant power will have to be connected at the plant site. The Kybernetes system will be used to monitor operating conditions during the various phases of the start-up of new petroleum refining, petrochemical and chemical plants. Later, the equipment will be used for periodic checks throughout the corporation's plant complexes.

In addition to logging 100 process variables, the Kybernetes system continuously scans for off-normal conditions. Process engineers will also use the system for dynamic analysis... selected groups of critical variables will be scanned at the rate of four points per second and recorded on high-speed punched tape for subsequent analysis. Hagan was awarded this order on the basis of a 5-year analysis of available equipment. The corporation's engineers decided that only the Kybernetes system was reliable enough for this type of service. (Details on request--Ask for Item N-1)

## ANOTHER ELECTRONIC COMBUSTION CONTROL SYSTEM FOR STEEL

Another Hagan PowrMag (magnetic amplifier) combustion control system for the steel industry is on order, this time for a bar heating furnace. To be fired with a combination of gas and oil, the furnace will be equipped with Hagan PowrLog recorders and PowrMag controllers. Basic in the selection of a solid state electronic system is the desire to make possible more centralized control, and the ability to transmit operating information over longer distances than is possible with pneumatic systems. The straight-forward engineering, simplicity and high reliability of Hagan PowrMag systems also played a large part in its selection. (Details on request--Ask for Item N-2)

## OPEN HOUSE DAY VISITORS SEE UNSCHEDULED EVENT

A brand new utility central station in the Mid-West was holding open house for their own officials and for invited representatives of other power companies in the area. During the course of the morning, another station in the same network dumped a 100,000 KW load due to electrical difficulties. The resulting surge overloaded the new station and the circuit breakers tripped out. Within fifteen minutes, the station was back in service, having demonstrated to the visitors that all equipment was well able to handle emergencies. Station officials were particularly proud of the performance of the control systems. As shown on the charts, the Hagan combustion, steam temperature and feed water control systems kept operating on full automatic during the unexpected shut-down, start-up period. (Details on request--Ask for Item N-3)

## AUTOMOBILE RADIATORS PROTECTED VIA HAGAN CONTROLS

Automobile radiator thermostats are pre-coated with solder and clamped together before being sent through a muffle furnace for brazing into a complete unit. To maintain flexure life, solder penetration must be firm, yet held to a minimum, therefore accurate control of furnace temperature is a must. The control system uses a Hagan Model P amplifier and a PowrMag controller...with these, furnace temperature of 1400F has been maintained within ±1°F, well within the required limits. Since solder penetration is a direct function of time and temperature, rejects will be held to a minimum by the accurate regulation made possible by the Hagan controls. (Details on request--Ask for Item N-4)

HAGAN CHEMICALS & CONTROLS, INC., Hagan Center, Room 713, Pittsburgh 30, Pa.

HAGAN DIVISIONS: CALGON CO. — HALL LABORATORIES — BRUNER CORP.

## End corrosion in gasket inventory

The gold Flexite Finish* for the metal gauge rings in Flexitallic Compression-Gauge Gaskets is new. It is highly corrosion resistant when exposed to severest weathering in open construction projects or in stock. The Flexite Finish provides for ease of identification and a clean, long-lived installation. Write for samples.

FLEXITALLIC GASKET CO., 8th & Bailey Sts., Camden 2, N. J.
Representatives in Principal Cities

TRADE Flexitallic® MARK
SPIRAL-WOUND GASKETS
WITH Flexite FINISH

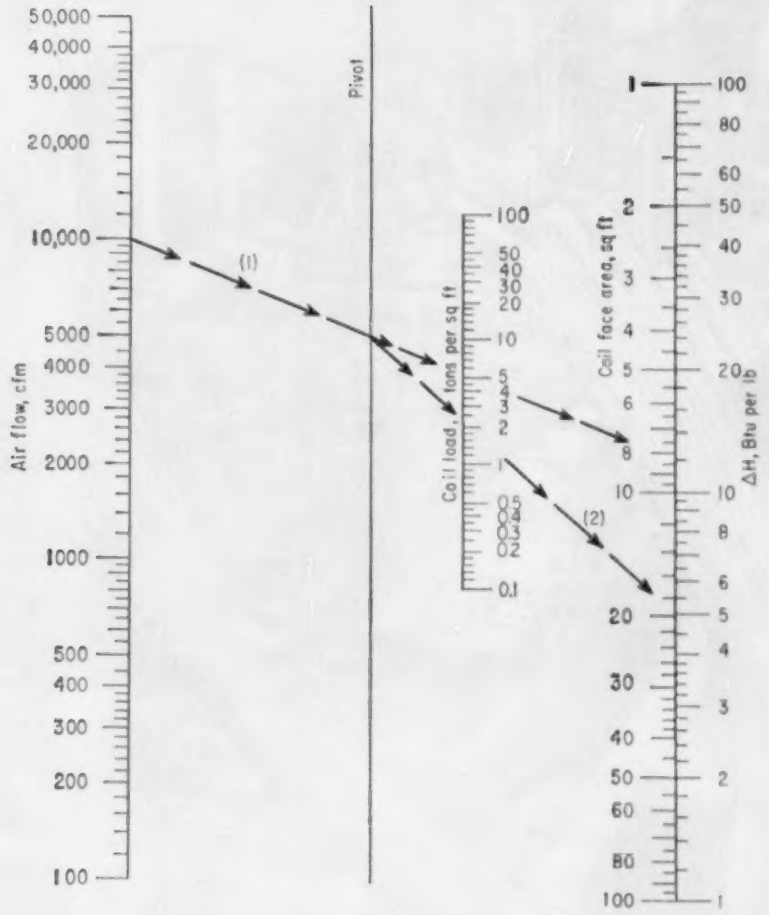
*The gold Flexite Finish is a development of the Flexitallic Gasket Co. (Originators of Spiral Wound Construction) – Register applied for on both name and color. Flexitallic Blue is our exclusive blue-dyed Canadian asbestos filler. Look for the blue and gold color combination as the mark of Flexitallic quality.

◀ For more facts circle 235 on Reader Service card, p 103

For more facts circle 236 on Reader Service card, p 103

# Power's data sheet

No. 334




## Calculate air-conditioning cooling-coil load

To choose chilled-water, brine or direct-expansion cooling coils for air-conditioning systems you must compute cooling load per unit area of the coil. This load is normally expressed in tons of refrigeration per sq ft of coil face area, though it can also be stated in Btu per hr per sq ft of face area. Coil cooling load per unit area is a function of quantity of air cooled, enthalpy change of air during passage through the coil and coil face area. Chart, above, eases computation of cooling load for any coil using chilled water, brine or refrigerant. Use the chart like this:

**Example:** Find cooling load on a chilled-water coil handling 10,000 cfm of air when enthalpy change through the coil = 12 Btu per lb and coil face area = 20 sq ft.

**Solution:** Enter chart at left, air flow = 10,000 cfm, and draw a straight line through enthalpy change = 12 Btu per lb, on right. From intersection of this line with pivot, draw a line through coil face area = 20 sq ft, on right. At intersection with second scale from right read coil load = 2.25 tons per sq ft.

This chart is based on $T = 4.5C(\Delta H)/12{,}000A$, where $T$ = coil cooling load, tons per sq ft; $C$ = air flow through coil, cfm; $\Delta H$ = change of enthalpy of air during passage through coil = entering-air enthalpy – leaving-air enthalpy, Btu per lb; $A$ = coil face area, sq ft. Constant 4.5 = 60 min per hr × 0.075 lb per cu ft (density of standard air); 12,000 = Btu per hr per ton of refrigeration.

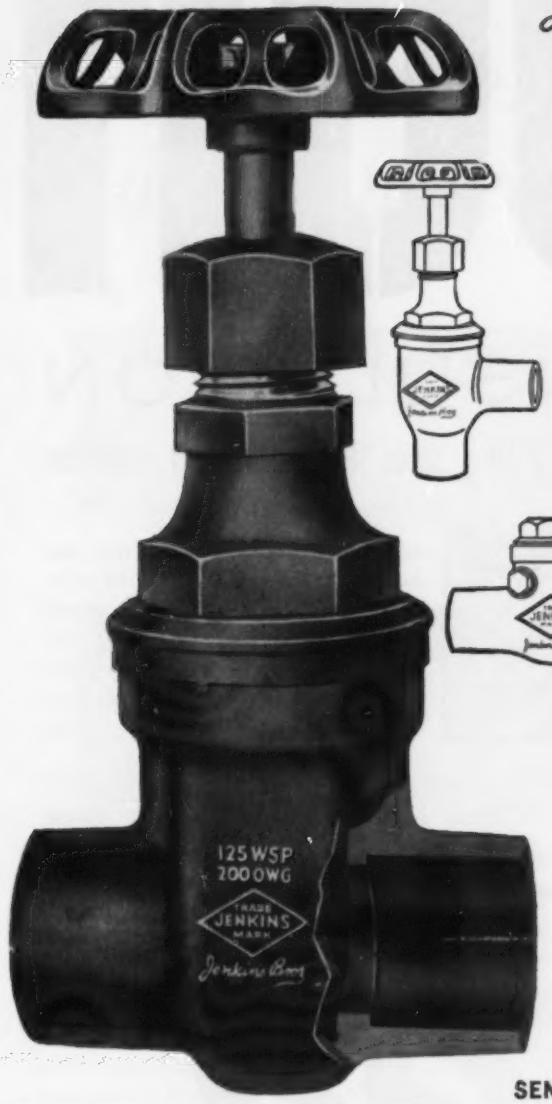
T G Hicks, *Hicksville, N. Y.*

© POWER

# A Reliable Way to Judge a COPPER TUBE Piping System

## . . . Look for this Mark JENKINS® of Quality Control

Jenkins Bros



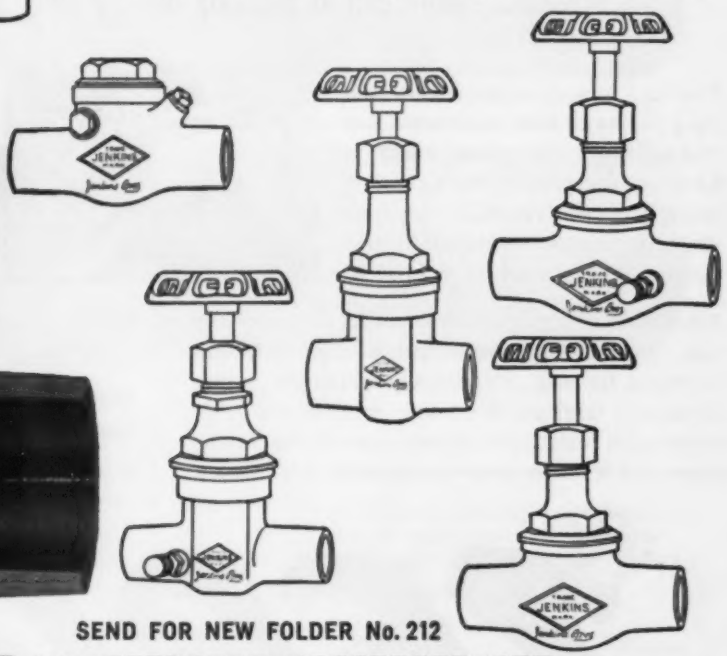

Surest kind of assurance that it is a QUALITY installation is given by the famous Jenkins "Diamond" on valves controlling the lines.

Where "anything will do", you're not likely to see Jenkins Solder (or Socket) End Valves. But you can expect to find them on jobs handled by engineers and contractors who know an economy installation is one you can forget.

*Compare* Jenkins Solder End Valves with any others. You'll see why they are trusted to give a lifetime of reliable service with a minimum of attention.

*Note* the thick, smooth bore solder-joint ends that withstand heating and contribute to a quick, leak-proof connection. Look inside at the many Jenkins superiorities in design and construction.

*A complete line* of top-quality Jenkins Solder End (and Socket End) Valves is available from your local Jenkins Distributor. Ask him to show you a sample of the type you require.



**SEND FOR NEW FOLDER No. 2 1 2**

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS SINCE 1864
Jenkins Bros

Jenkins Bros., 100 Park Avenue, New York 17
Send folder No. 212 describing all Solder End and Socket End Valves.

Name & Title.....

Company.....

Address.....

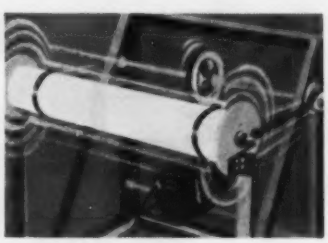
For more facts circle 237 on Reader Service card, p 103

# TOUGH

## NEW PIPE INSULATION

### ...deflection at breaking point 2 to 4 times that of ordinary insulation

You can almost forget about handling breakage with remarkable new "K&M" Zebra. As proved in tests by K&M and independent testing laboratories, Zebra won't crack or warp from shock or heat. It withstands intense vibration without cracking or abrading.



Zebra is made in half sections even for the larger pipe sizes . . . for faster application with fewer joints. Despite its rugged, full body, it's relatively lightweight . . . easy to cut and fabricate. It's a low, medium and high-temperature multi-layer sectional-type thermal insulation. And it meets your requirements for density, conductivity, modulus of rupture, and resistance to soaking heat. Write today for more information and a free sample of new "K&M" Zebra. It's tough, economical, fast to apply. That's Zebra . . . by K&M! Keasbey & Mattison Company, Ambler, Pa. Dept. I-160.

*• for temperatures of 200° F to 1200° F • smooth surface won't irritate or cut skin • made of calcium silicate-asbestos fiber bonded felts • can be re-used . . . dismantled and re-applied • practically dust-free • available in a wide range of sizes and thicknesses.*

# ZEBRA

K·M

# KEASBEY & MATTISON at Ambler

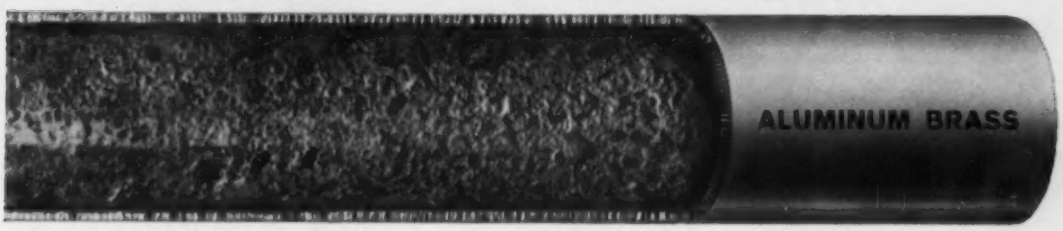


For more facts circle 238 on Reader Service card, p 103

# BRIDGEPORT ANNOUNCES

# ALLOY 77*

## *new condenser tube alloy radically reduces biofouling*




After cleaning, the Alloy 77 tube (top) shows considerably less corrosive attack than the aluminum brass tube (bottom). Both tubes were exposed to identical operating conditions.

Metallurgical history is being made by Bridgeport's use of Mercury as the corrosion inhibitor in Alloy 77, the first completely new condenser-tube alloy developed in years. Startling advantages for this alloy have been uncovered during 18 years of continuous laboratory and field service tests.

Alloy 77 does what has never been done before in the control of biofouling. The Mercurial Brass Alloy kills living biorganisms before they have a chance to attach themselves to tube interiors. Costly chlorination treatments are reduced and no unusual cleaning methods are needed.

Chlorine Dollars, Cleaning Dollars, Lost Heat Transfer Efficiency Dollars can be saved when you tube or retube with Bridgeport Alloy 77. Full details can be had immediately from our Technical Data Folder. A request to Dept. 5403 for "77" will get you your copy.

*U.S. Patent No. 2,887,374, May 19, 1959

**The advantages of Alloy 77 have been proven time and again in sea water, fresh water and brackish water. Check these advantages:**

1. **Radically reduced biofouling**
2. **Higher transfer efficiency**
3. **Excellent general corrosion resistance**
4. **Forms soft, thin, powdery scale**
5. **Simple, easy cleaning**
6. **Field tested performance**

**BRIDGEPORT BRASS COMPANY**

*Bridgeport 2, Connecticut* — *Specialists in Metals from Aluminum to Zirconium*

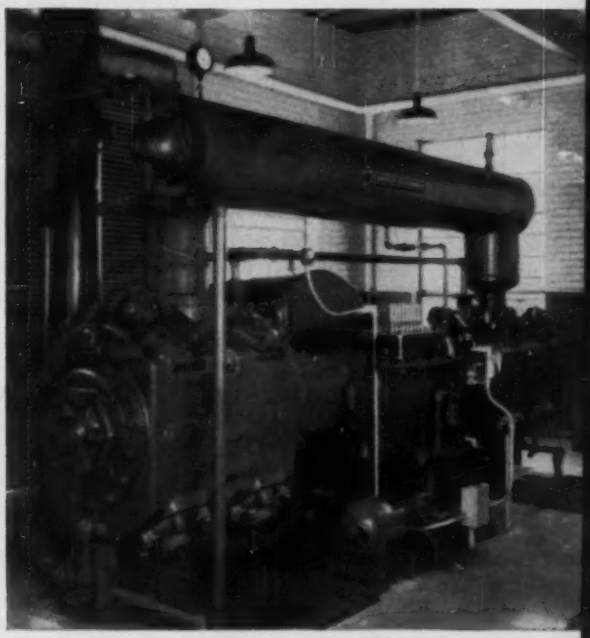


For more facts circle 239 on Reader Service card, p 130

George Edick, *Domestic Sales Manager, The Cooper-Bessemer Corporation, and* Floyd Paschke, *Sales Manager, The Rotor Tool Company, explain...*

# HOW TO BOOST YOUR PRODUCTIVITY WITH COMPRESSED AIR

*Installing a Cooper-Bessemer DMR-3 Air Compressor for foundry service. Capacity is 1670 cfm at 110 psig discharge. Other units available for service down to 572 cfm.*



*Cooper-Bessemer Model EM Air Compressor in a metal-working plant. Rated 1125 cfm at 110 psig discharge. Other models in ratings up to 10,000 hp.*

The thing that counts in getting top output with air tools is *air pressure at the tool, under load.* Is this productivity what it should be in *your* plant? Here is a service that helps you find out *for sure* . . .

The teaming up of application service engineering of Cooper-Bessemer and its new subsidiary, Rotor Tool, provides full-scope experience to help you analyze your compressed air needs and plan your facilities for optimum production efficiency. This experience encompasses the study of compressor capacity requirements, number of compressors and their location for greatest economy, regulation of the plant, the distribution system and portable air tools. This service is yours without obligation.

It will pay you to call in the nearby application engineer of Cooper-Bessemer or Rotor Tool to help you make sure that you are getting maximum productivity with compressed air.

*BRANCH OFFICES:* Grove City • New York • Washington • Gloucester
Pittsburgh • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans
Shreveport • Houston • Greggton • Dallas • Odessa • Pampa • Casper • Seattle
San Francisco • Los Angeles

*SUBSIDIARIES:* Cooper-Bessemer of Canada, Ltd. . . . Edmonton • Calgary
Toronto • Halifax • Stratford

C-B Southern, Inc. . . . Houston

Cooper-Bessemer International Corp. . . . New York • Caracas • Anaco

Cooper-Bessemer, S.A. . . . Chur, Switzerland • The Hague, Netherlands • Mexico City

The Rotor Tool Company . . . Cleveland

Cooper Bessemer

**GENERAL OFFICES: MOUNT VERNON, OHIO**

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL,
ENGINE, TURBINE OR MOTOR DRIVEN

**For more facts circle 240 on Reader Service card, p 103**

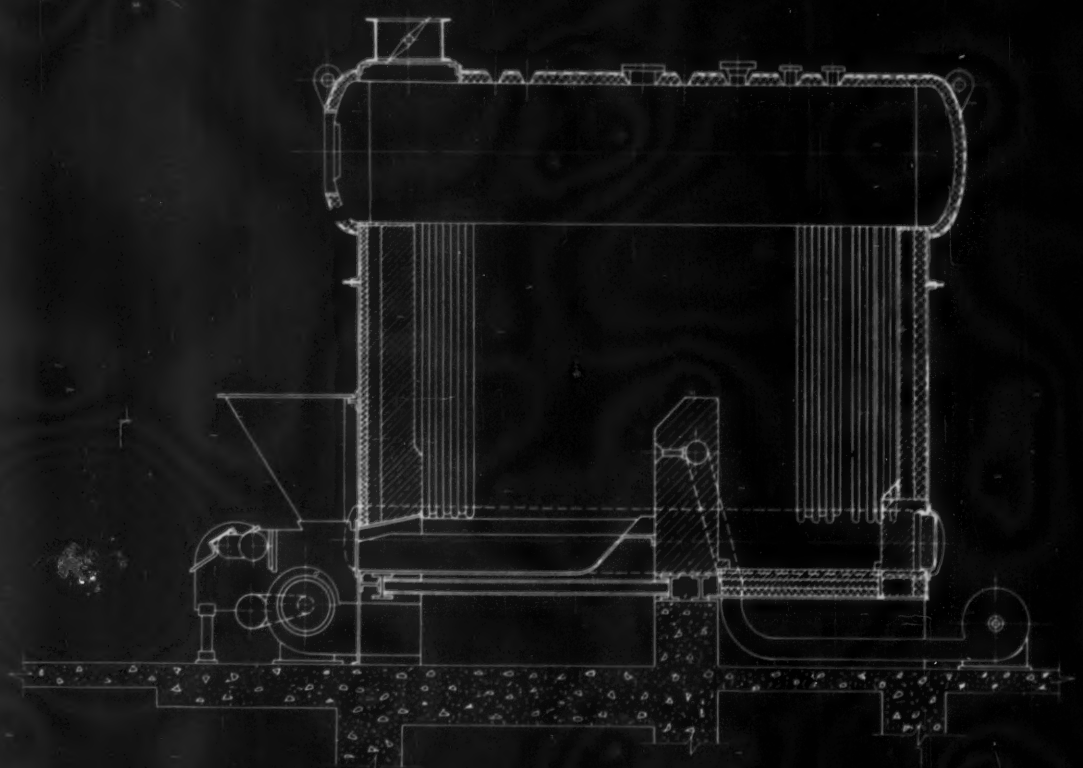
*you can take full advantage of the fuel situation with*

# WICKES

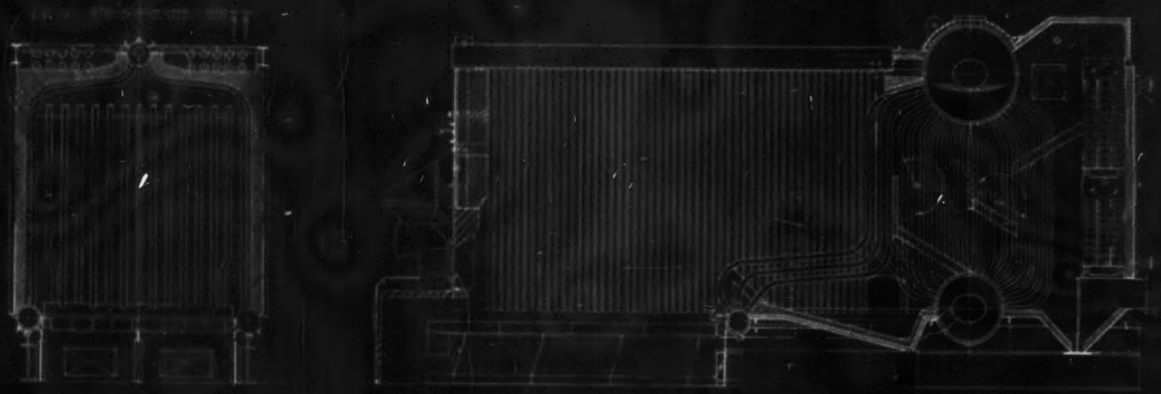
# PACKAGE STOKER-FIRED STEAM GENERATORS

**Designed and built to WICKES recognized standard of excellence, engineered to WICKES high standard of efficiency**

These stoker-fired WICKES generators are compact, package water tube boilers, custom-engineered to your exact steam generating requirements. Semi-automatic in operation and convertible from stoker-fired to either gas or oil fired, these WICKES generators are built to the highest standards of workmanship to give you the same efficiency of operation that you have come to expect from all WICKES-built boilers. They are built in a variety of designs to meet size, space and fuel conditions. For complete information on these WICKES stoker-fired units as well as the complete line of WICKES water tube steam generators, ask the WICKES sales representative nearest you to call . . . offices in principal cities*.



TYPE A



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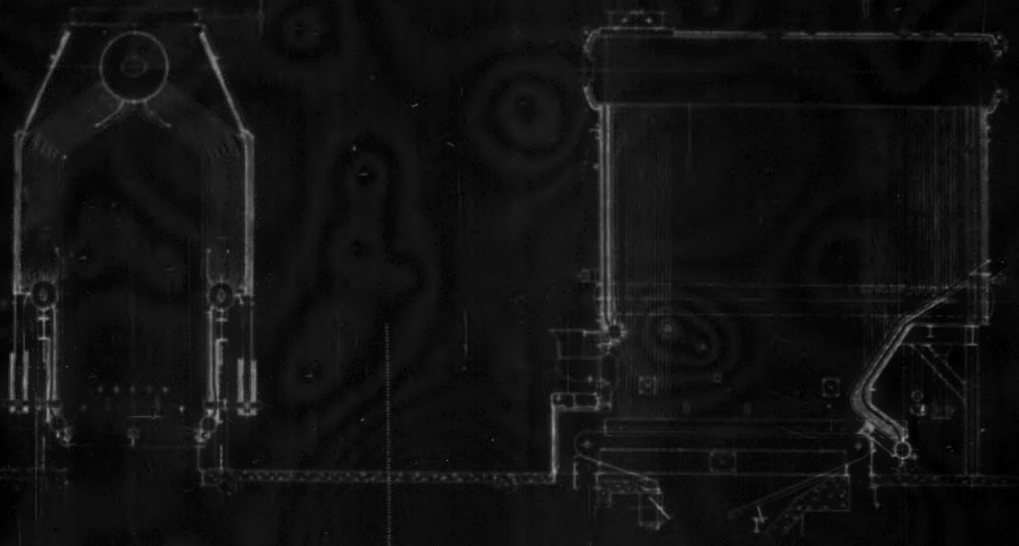

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DIVISION OF THE WICKES CORPORATION

For more facts circle 241 on Reader Service card, p 103

# Technical briefs ... Latest engineering

## American Power Conference covers the water front: supply and treatment

**Sea-water conversion—byproduct of power,** *G F Leitner, Cleaver-Brooks Special Products, Inc*

Flash evaporator for salt-water conversion installed at Mandalay Station of Southern California Edison Co has 26 stages and can be operated on once-through or brine-recirculation system. Unit will serve to develop cost data and experience for studying larger power-distilling-plant combinations.

Bases of unit development include review of production costs and available heat sources—stack gases, condenser circulating water and extraction steam. *APC—1960*

**Industrial-water use in Illinois,** *W J Roberts, Illinois State Water Survey*

Recent survey reveals total water use in Illinois excluding hydro power is 11,800 mgd—up 42.6% since 1950. Use growth exclusive of all electric-power generation has been 206 mgd or 9%.

Water provided by public facilities to industry (392.5 mgd) breaks down into 91% surface, 9% ground water. Private facilities provide bulk of industrial water (11,000 mgd).

Currently, Illinois boasts 29 steam-electric-power plants of over 20-mw capacity, with a combined pumpage of 9051.3 mgd. The 1950 figures showed 21 plants pumping 5927 mgd, so pumpage capacity has grown by 53%.

Heaviest pumping concentration is in the northeast corner of Illinois, including the Chicago-area river system: Chicago Sanitary and Ship Canal, Calumet River and North and South branches of the Chicago River. Additions to steam-power plants next year will add 26% to current pumping rates.

In 1950 Illinois had 13 hydro plants. Retirements reduced this to 11 in 1959. Current water use charged to Illinois sources is 21,155 mgd for 161.4-mw installed capacity. *APC—1960*

**Zero-solids treatment of high-pressure boilers,** *R I Smith, Public Service Electric and Gas Company*

Zero-solids treatment at Public Service Electric and Gas Co covers eight units installed since 1953—drum pressures from 2327 psig to 2587 psig. In each case treatment procedures and operating experience is detailed. All makeup is demineralized; hydrazine, ammonia treatments complete picture.

Boiler operation has been highly satisfactory in all except three units. Here percent makeup is high because of steam supplied to an adjacent refinery (no return condensate), but makeup quality has been consistently excellent. Several boiler-tube failures and need for frequent acid cleanings are as yet unexplained but under study. *APC—1960*

**Cooling-water-inhibitor performance: film formation vs film maintenance,** *P R Puckorius and W J Ryzner, Nalco Chemical Company*

Laboratory tests confirmed by field data with phosphate- and chromate-based inhibitors in open cooling-water systems show mechanics of film formation. Conclusion: initial high-dosage rates with proper pH control should be followed by maintenance-level dosage.

If maintenance level is used initially, consumption of inhibitor reduces concentration to point where film cannot form. Corrosion proceeds at a high rate forming porous, unprotective products.

Laboratory tests of mild-steel (AISI 1010) and arsenical-admiralty coupons lasted about 14 days. Typical test used 60 ppm for four days to form protective film. Then concentration was dropped to 20 ppm as maintenance level.

Corrosion-rate monitor will indicate need for resumption of high dosage level to renew film after loss. *NACE Annual Conference, Dallas, Texas, March 1960*

## Pumps and bearings

**Performance tests of water-lubricated bearing materials for condenser-circulating pumps.** *F L Yetter, C H Diehl, C H Wheeler Manufacturing Co*

Bearing test program was established to closely simulate field operation of condenser-circulating pumps. For flexibility, 24 duplicate test machines permitted operation with over 90 material combinations in a relatively short time. Basic bearing tested was 0.875-in. nominal size. Usual prototype surface speed is 600 to 800 fpm with a maximum-projected-load-area loading of 15 to 20 psi, but in these tests the load was upped to 50 psi and speed maintained at 800 fpm to accelerate wear rate.

Tests showed that carbide family is far superior to any other type of material evaluated. Wear was very low and after a break-in period the increase was practically nil. Combination of metal bearings and carbide journals also gave long life and low wear because of carbides' nongalling action. Of other materials used for condenser-circulator bearings, leaded bronze and "filled" Teflon running on stainless-steel journals showed up best. While these materials wore more than the carbides, they wore much less than other materials of the same type. All the ceramics, plastics and usual bearing metals tested failed rapidly under high surface speed and load. The ceramics failed structurally, plastics by melting and metals by galling. *APC—1960*

15 papers for you on:

PUMPS
FUELS AND ASH
BOILERS AND AUXILIARIES

# developments for busy power men

**Selection of boiler-feed pumps and drives for a 265,000-kw unit,** *J C Beres and R W Potts, Commonwealth Associates, Inc*

Boiler-feed-pump type and arrangement evaluations have become increasingly important and complex with larger unit sizes. Three basic drives available are electric motor, mechanical-drive steam turbine and turbine-generator. Number of pumps used and various speeds for each drive multiply alternates.

In evaluating boiler-feed pumps for a 265-mw unit, Commonwealth Associates first determined optimum speed and number of pumps required for each drive arrangement. Three drives were then evaluated against each other. From this process, half-capacity turbine-generator-driven 3600-nominal-rpm pumps emerged with a $229,500 advantage over motor-driven pumps and a $178,000 advantage over steam-turbine-driven pumps.

Basis of evaluation process was: (1) net kw capability held constant (2) 0.63 capacity factor for 35 yr (3) fuel cost at 40c per million Btu, increased at 2% per yr over the 35-yr life (4) differences in reliability allowed for by an outage penalty (5) direct-connected exciters included in all cases and (6) fixed charges at 15%. *APC—1960*

## Condenser operations

**Plant test of a 95,000-sq-ft condenser,** *W E Glausser, C H Unruh and G Balekjian, C F Braun and Co*

Field tests of a 95,000-sq-ft-surface condenser at Scattergood Station of Los Angeles Dept of Water and Power revealed much detailed data. Condenser is single-pass type with 70-30 copper-nickel tubes, tube sheets and clad waterboxes.

Extensive instrumentation gave consistent data on backpressure, pressure drop, heat-transfer rates and $O_2$ removal. All test equipment, procedures and results are detailed.

Conclusions show advantage of steam *temperature* rather than *pressure* measurement in exhaust neck since temperature is not affected by turbulence or velocity head. HEI overall coefficients for 70-30 copper-nickel tubes lie about 20 to 35% below clean-tube performance. Initial fouling rates decrease markedly after a few days, and coefficient becomes 90% of HEI value after several months. *APC—1960*

**Some hydraulic aspects of condenser circulating water systems,** *R A Wilson, Allis-Chalmers Manufacturing Company*

Factors affecting siphon operation and head recovery in condenser circulating-water systems are covered in detail. These include (1) parallel operation of siphons (2) venting (3) inverts (4) Manning's formula and (5) solubility of air in water.

Slanting siphon lines sometimes used to cut costs can be points of continuing trouble during operation—head recovery is impaired and venting problem magnified. Use of slanting siphon lines should be avoided wherever possible. Methods of system priming include steam, water and air jets. Design-capacity guides are given for priming. *APC—1960*

Directions for ordering these papers on page 102

## Fuels and ash

**Fundamentals of fuel-oil combustion,** *D S Frank, The Pure Oil Company*

In spite of great technical advance, fuel burning is still more of an art than a science, and experience is the best guide to successful operation. Of all factors in fuel-oil specification, viscosity is apparently least fully appreciated. Yet viscosity and its change with temperature have a marked effect on burner operation.

Since No.-6 fuel-oil specifications show such a wide viscosity range (45 to 300 ssu at 122 F), you must know viscosity index. In one instance, burner manufacturer recommended 80 to 100 ssu. Sooting problem was solved by using viscosity index to show needed increase in preheating temperature.

A few hints for better burner operation: Be sure (1) of adequate preheater temperature (2) atomizer cup, sprayer plate or tip is not worn (3) burner is centered in refractory cup and flame just clears refractory cone (does not impinge on it) (4) of sufficient primary air (5) angle of tip or cup is OK, and (6) not to push burner much beyond its rated capacity. *APC—1960*

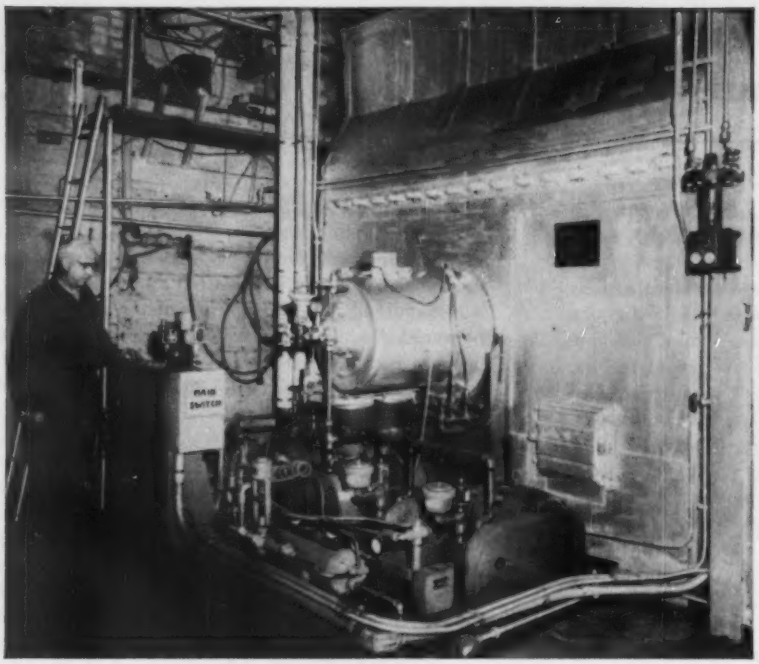
**Measurement of density and moisture in large coal-storage piles,** *B B Bonadio, Indiana-Kentucky Electric Corp, A S Grimes, American Electric Power Service Corp, H I Lamphier, Ohio Valley Electric Corp*

Physical characteristics of large coal piles—density and moisture—must be representatively determined for accurate inventory. Million-ton piles are not uncommon today, so nominal measuring errors can represent a substantial quantity of coal.

New density probe contains gamma-radiation source. Amount of radiation scatter is essentially a function of material density, and electronic scaler counts pulses from detector per time unit. Moisture probe contains fast-neutron source but detector is sensitive only to slow neutrons. Since $H_2$ is the principal neutron moderator present in coal, instrument can be calibrated in terms of total $H_2$ content.

Equipment and test procedures are detailed. Test results show need for additional study of moisture effect on density readings and other unexplained test variations. *APC—1960*

continued



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## Technical briefs

Begins on page 96

**Ash-handling equipment for industrial power plants,** *A M Perrin, National Conveyors Company*

Industrial ash-handling systems meet plant needs best when individually designed for specific requirements. But specifications should neither be hybrid, requiring costly integration of nonstandard equipment, nor overly detailed, preventing bidders from offering latest improvements for fear of disqualification. Sizing ash-handling systems depends on many factors besides daily capacity. These include ash quality (clinkers and dust) and plant layout.

In a steam-pneumatic ash-conveyor system, equipment-cost breakdown shows about 8% for ash-conveyor fittings, 10 to 15% for ash-conveyor pipe, 30 to 35% for ash-storage bin and discharge gate, 22% for ash-receiving equipment, separator, exhausters and air washer and 20 to 30% for controls, ash hoppers and miscellaneous equipment. In addition, about 35 to 50% of total installed cost will be taken up by labor and supervision of installation. *APC—1960*

### Hydraulics

**Charts for determining size of surge suppressors for pump-discharge lines,** *C W Lundgren, Bureau of Reclamation*

In normal water-supply systems, power failure rapidly reduces pump speed. Water momentum creates low pressure in the pump-discharge line, and actual water separation if pressure drops below vapor pressure. Water column then reverses direction, producing very-high pump-discharge pressures. Water hammer results. When water separation does not occur, pressure rise can be as high as static head on pump discharge.

Surge suppressors are really high-capacity relief valves at pump discharge, designed to control high pressure surge by rapid dumping on power failure. They are actuated by either the power failure itself or line-pressure reduction.

Quantity of dump to limit pres-



For more facts circle 242 on Reader Service card, p 103

# A Nalco PRODUCT MANAGER

## Answers Questions about Cooling Tower Deterioration And Other Microbiological Problems

### More Knowledge, Better Chemical Controls Offer New Paths to Economical Tower Treatment

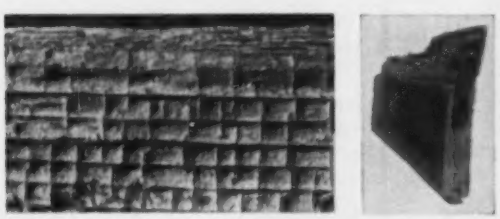
Since cooling towers offer many types of fungi and bacteria choice conditions for growth, the battle for microbiological control is a continuing one throughout the country.

Nalco approaches cooling tower protection as part of the overall job of keeping the entire cooling system free of scale, corrosion, and microbiological growths of all kinds. Such a complete program is essential for most efficient cooling tower and system operation.

Here are some of the frequently-asked questions about cooling tower deterioration; and the answers we believe to be accurate.

**Question:** How can you tell when wood is being attacked chemically or microbiologically?
**Answer.** Careful tower inspection, plus microbiological analyses of wood from various parts of the tower (framing, fill, mist eliminator, top deck, and stack), and from samples of cooling water.

**Question:** Is wood deterioration common to certain parts of towers?
**Answer.** No. Microbiological attacks may occur in any part of the tower. Internal decay or deep rot is common to non-water-washed sections; while surface decay or chemical attack may occur anywhere in the system.



**Wood deterioration samples from cooling towers. Left, cross checked surface decay; right, deep internal rot.**

**Question:** Does tower location make any difference?
**Answer:** Apparently not. Towers throughout the world have been attacked.

**Question:** What types of organisms produce wood decay?
**Answer:** The same ones that produce forest decay. Organisms of the Fungi Imperfecti class cause both surface decay and internal rot. Deep rot is also caused by fungus organisms of the Basiodiomycetes class. Both classes are cellulolytic organisms—cellulose eaters, in effect, as they convert cellulose for nutrient uses, and in so doing, weaken the wood to the point of eventual collapse.

**Question:** Does chlorine predispose wood to microbiological decay?
**Answer:** There are considerable data, gathered by interested independent organizations, indicating that deterioration is prevalent in towers using chlorine as an algicide and bactericide. Whether chlorine predisposes wood to decay has not been fully established. However, actual plant experience indicates that a non-oxidizing microbiological program can provide control of wood deterioration. Nalco non-oxidizing microbiocides can also be used to provide protection against decay where chlorine is a part of the overall control program.

**E. H. Hurst, Product Manager, Water Stabilization Chemicals, Nalco Chemical Company**

**Question:** Do any chemicals do a complete job of microbiological control in cooling towers?
**Answer:** Yes. A Nalco program of non-oxidizing microbiocides designed and engineered for your plant problems can provide complete control against all types of microbiological activity . . . slime, algae, corrosive bacteria and wood decaying organisms.

**Question:** Do these non-oxidizing microbiocides *stay* effective? Economically?
**Answer:** Yes, although changes or additions in the types of organisms present may change the type or dosage of treatment used. Nalco programs have the flexibility required to meet such changes and maintain effective control. Long-range economy of a Nalco program for complete cooling system protection is being demonstrated in hundreds of systems—some of them for twenty years or more!

**Question:** Is this the whole story on microbiological control and deterioration?
**Answer:** It is hardly a beginning! Details on Nalco chemicals and services, and specific programs for cooling system protection are available promptly from your Nalco Representative. Ask him about the searching, comprehensive surveys and analyses made before a program is recommended . . . About the continuing surveillance of program effectiveness and economy . . . And let him show you, specifically, what Nalco can do for you.

**On request:** An illustrated, 8-page report on "Cooling Tower Deterioration . . . Its Causes, Symptoms, and Suggested Cures." Ask for Nalco reprint No. 85.

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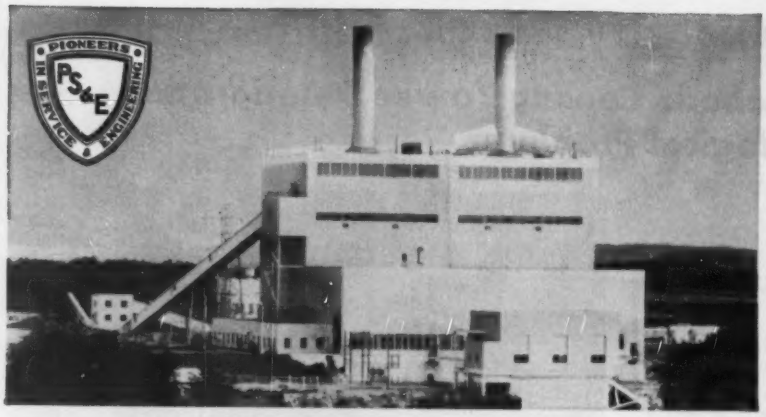
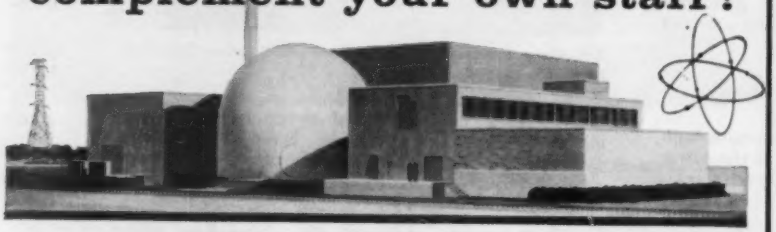
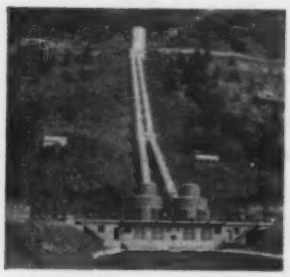
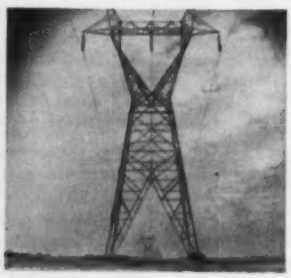



**Which Pioneer service do you need to complement your own staff?**







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## Technical briefs

Begins on page 98

sure rise is graphically determined for pressure rises of 0, 10, 20 and 30% of initial head. Curves for each pressure-rise limit relate pipeline constant to ratio of discharge and suppressor capacities. Charts apply *only* where water separation *does not occur. ASME 59-A-73*

**Viscous dispersion in water hammer,** *M L Walker, Howard University, E T Kirkpatrick, University of Toledo and W T Rouleau, Carnegie Institute of Technology*

In practical water-hammer problems the following simplifying assumptions are usually made: (1) instantaneous valve closure (2) an inviscid fluid and (3) a rigid conduit. Result produced is upper limit of pressure.

This study determines whether or not inclusion of viscous dispersion gives a more-conservative upper pressure limit. Formulas are derived to include this effect and numerical calculations electronically made. Results show that in all practical water-hammer problems, consideration of viscous dispersion does not provide a better upper limit of pressure; you'll do just as well assuming an inviscid fluid. *ASME 59-A-12*

**Safety aspects of a pressurized-water nuclear-reactor power plant and associated instrumentation and control requirements,** *C F Obermesser, Westinghouse Electric Corporation*

The very nature of nuclear-power plants emphasizes the importance of safety. Adequate protection for plant operators and neighbors as well as protection of investment is the safety criteria for plant designers.

Since startup and shutdown are the most critical periods from an accident point of view, discussion centers in this area. Possible causes and sequence of events leading to accident situations are discussed; in each case, required safety devices and procedures are detailed. Inherent safety of pressurized-water-reactor power plants together with well-designed instrumentation and other safety systems minimizes hazards in plant operation. *AIEE CP 60-148*

continued



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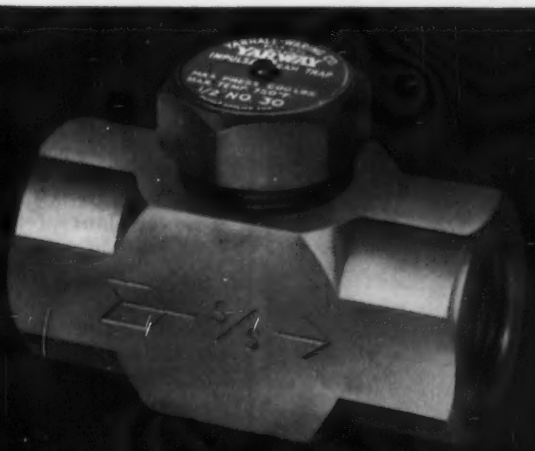


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## TYPE CB
# SCREW PUMP

*Specifications for High Pressure Fuel Oil Service:*

**Body**—Heavy walls for high pressures. Two intersecting body bores ground parallel to close tolerances along entire length. Suction and discharge flanges standard ASA.

**Center Bearings**—Two fixed double-row, heavy duty, roller bearings at middle of span ***control possible shaft deflection at high pressures.*** Bearing housing bores ground with body bores insure concentricity. All bearing parts are ground to close tolerances for low operating clearances.

**Pumping Screws**—Two opposing pairs of intermeshing screws maintain pump in axial hydraulic balance ***regardless of discharge pressure.*** A specially generated straightline profile between screws results in minimum slip. Screws are machined for close tolerance between body and screws, and between intersecting screws.

**Timing Gears**—***Have increased face width for high pressure service.*** Proper positioning at factory prevents metallic contact between screws, eliminating vibration and noise while transmitting power smoothly.

**Inboard and Outboard Bearings**—Standard, and selected for maximum life based on pump's maximum operating conditions. Each timing gear is supported by a pair of double-row, heavy duty roller bearings to isolate radial loads from screws.

**Shafts**—Designed for both high speed and high torque applications.

**Stuffing Box**—Under suction pressure only. Valve control can be provided for pressure lubrication and sealing.

**Mounting**—The pump is adaptable for horizontal, vertical or inclined installation.

***For complete details, including Selection Nomograph, write for Bulletin 252.***

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## Technical briefs

Begins on page 96

### Safety

**A power-plant safety program,** ***W C Kramer, Commonwealth Edison Company***

Power-plant safety program at State Line Station of Commonwealth Edison Company is designed from the bottom up rather than imposed from the top by management. Employee-elected Safety Investigating Committee implements safety ideas and enlists aid of management's Central Safety Committee only when required.

Safety program is based on: (1) employee responsibility (2) safety as integral part of the job (3) safety never precluded by urgency (4) sincere management cooperation and (5) safety as a way of life—on and off the job.

Large employee safety meetings gave way to smaller groups. Employee interest and participation grew. Result: improvement of safety record at State Line Station has been impressive. There have been several million-manhour periods without disabling injury. *APC—1960*

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**ADVERTISED PRODUCTS appearing throughout the issue**

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# New free literature

### AIR CONDITIONING, HEATING AND VENTILATION

**101** **Air-conditioning,** heating and ventilating equipment, firm's new lines, are covered in 8-p bulletin. The Trane Company

**102** **Portable ventilators,** man-cooling fans are topic of catalog 150. Most profitable ways to use air are discussed. Coppus Engineering Corporation

**103** **Industrial furnaces** for any application are subject of well-illustrated folder. Sunbeam Equipment Corporation

**104** **Propeller fans** are covered in 16-p bulletin A-109E. Section on corrosion-resistant materials and coatings is included. Hartzell Propeller Fan Co

### METALS AND MATERIALS

**105** **Use of steel castings** in light and power industry is featured in 28-p booklet. Steel Founders' Society of America

**106** **Heat-resistant castings,** corrosion-resistant castings, their engineering properties and applications are covered in 64-p booklet. This is divided into three sections for easy reference. The International Nickel Co, Inc

**107** **Insulations** for service from sub-zero to 1900 F are presented in 24-p catalog of recently merged firm's complete line. Selection chart indicates temperature range of various types of materials. Specs are included. Baldwin-Ehret-Hill, Incorporated

**108** **Fluorinated chemical** compounds having industrial applications are reviewed in revised 12-p bulletin 12-A. Physical properties, chemical reactions, applications are described. Hooker Chemical Corporation

**109** **Hardness-** and tensile-strength relationship of carbon and alloy steels is covered in hardness-conversion chart. The Babcock & Wilcox Company, Tubular Products Div

**110** **Coatings** of high-melting-point materials, metals, ceramics and carbides are topic of 16-p engineering-data bulletin. Flame-spraying process is covered. Metallizing Engineering Co

**111** **Vacuum-melted h-t alloy** is subject of 12-p technical data bulletin. Applications, metallurgical characteristics, physical properties are discussed. Westinghouse Electric Corporation

**112** **Nonferrous alloys,** comparative specs, chemical analyses are charted in fold-out bulletin. Shenango Furnace Company, Centrifugally Cast Products Div

### COMPRESSORS AND ACCESSORIES

**113** **Compressed air** for industrial needs is topic of 16-p bulletin 94 describing firm's line of industrial

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air compressors. The Cooper-Bessemer Corp

**114** **Rotary screw type** air compressors are subject of 4-p folder A-1-141. Atlas Copco

**115** **Drying compressed air** for entire plant is described in 16-p moisture-control bulletin. Van Products Company

## ELECTRIC GENERATION AND TRANSFORMATION

**116** **Mobile substations** and transformers with ratings up to 20,000 kva, 115 kv for substations, 40,000 kva, 138 kv for transformers are topic of descriptive 24-p bulletin GEA - 4415C. General Electric Company

**117** **Transformers** for service up through 10,000 kva, 69,000 v are discussed in 4-p well-illustrated bulletin 139. Niagara Transformer Corp

## ELECTRICAL DISTRIBUTION AND PROTECTION

**118** **Distribution equipment,** low-voltage type, is covered in firm's 84-p *Buy Log* GEC-1100B. This covers switches, wireways, circuit breakers, switchboards, motor-control centers, distribution centers and all types of panelboards and busways. General Electric Company

**119** **Relay manual** features 80 types of relays for communications, computers. Manual has 40 pp. Cook Electric Company

**120** **Relay coils** are discussed in 2-p bulletin. Use of special bobbins is explained. Tur-Bo Jet Products Company

**121** **Portable cord** of special copper alloy is discussed in publication WC-8140. Cord is rated 600 v. General Electric Company, Chemical and Metallurgical Div

## ELECTRICAL APPLICATION

**122** **Ac magnetic starters** are topic of 8-p bulletin PL 12-8-160. Enclosures, forms and combinations of all starters are illustrated. Clark Controller Co

**123** **Gear motors** and separate motor reducers are featured in 8-p bulletin 198. Design features, types and modifications are described. Sterling Electric Motors, Inc

**124** **Controlled-speed systems** are topic of 8-p bulletin. Photos, drawings explain controlled-speed-system principle. U. S. Electric Motors Inc

**125** **Application guide** to rotary solenoids, selectors and stepping motors has eight pp, drawings, charts, photos, diagrams. Physical performance and environmental data on more than 250 models is given. G H Leland, Inc

June 1960 issue

## Circle numbers below for FREE data

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**PLANT EQUIPMENT in the news this month, starting on p 128**

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76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

**NEW LITERATURE listed in this issue, starting on p 104**

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NEW FREE LITERATURE continued..... .....circle key numbers, page 103, for your copies

**126** **Submersible pump motors** are described in 8-p brochure F-2000. Exploded and assembled views of thrust bearing of 5- to 300-hp units are given. U. S. Electrical Motors Incorporated

**127** **Firm presents eight values** of their line of electrical motors in folder F-1974. U. S. Electrical Motors Incorporated

**128** **Drippproof,** totally enclosed polyphase squirrel-cage motors, 1 hp and larger for close-coupled centrifugal pump applications, and 1/6- to 10-hp motors are covered in new product bulletins. Wagner Electric Corp

**129** **Brushless rheostat** is topic of 4-p bulletin. Complete specs, price list are given for unit which is sensitive to less than 0.0001 in. Electric Regulator Corp

**130** **Lighting fixtures** with or without porcelain reflectors are introduced in 4-p form 1099-60. Steber Mfg Company

**131** **Precision-drawn closures** from transistor caps to transformer housings are featured in folder. Hudson Tool & Die Co, Inc

## INSTRUMENTATION

**132** **Loading reactor** for laboratory load testing, test, inspection, research and development use is topic of 2-p bulletin. The Superior Electric Company

**133** **Transistorized** pipe, valve and cable locator is described in 2-p brochure. Gardiner Electronics Company

**134** **Speed detector** for fuel and fuel-mixture control of power gas burners is topic of bulletin 265. Torq Engineered Products, Inc

**135** **Units for position-proportioning** control of motors or other actuators are explained in sheets 8801-4 to 8801-6. Minneapolis-Honeywell Regulator Co

**136** **Miniature infrared photoelectric** scanner for conveyor control, feed-failure detection is covered in 2-p data sheet 260. Farmer Electric Products Company, Inc

**137** **Progress report** on continuous fluoroscopic inspection of submerged arc-welded pipeline is available from Phillips Electronic Instruments

**138** **Fluid meters,** operation, ranges and installation requirements are included in 8-p bulletin 30. Bailey Meter Company

**139** **Automatic** flow controls for low pressure drop are featured in

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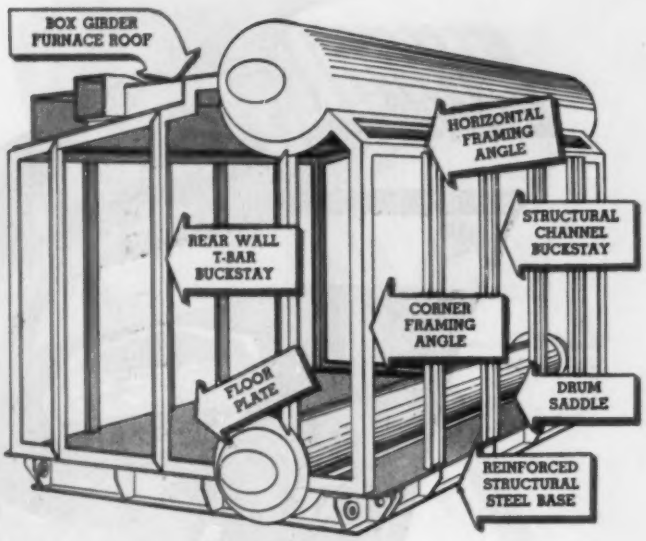
Because water tube packaged boilers have positive pressure furnaces, their outer casings must be welded to prevent gas leakage. But welded casings without reinforcing do not provide sufficient strength to resist the stresses of movement resulting from expansion . . . which causes thin casings to break at the welds, and permits gas to escape.

To eliminate the problem, Superior Packaged Boilers are built within a structural steel frame and covered with casings of heavy steel of sufficient thickness to permit heavy welded joints to structural members.

Only Superior Packaged Boilers provide 10-gauge steel casing reinforced with 4" channel iron buckstays every 24" and casings welded to both legs of the channel.

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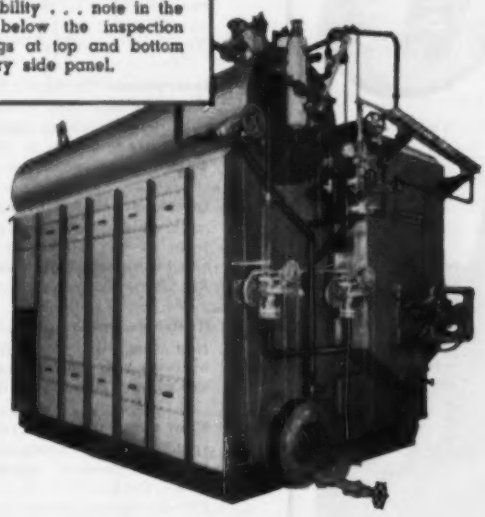

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For installations requiring capacities from 11,000 to 61,000 lbs of steam per hr. or more, Type D Superior Packaged Boilers provide the ideal answer. True packages, thoroughly engineered, Type D boilers utilize the proven D type tube arrangement. Equipped with either rotary cup or steam atomizing burners and a wide variety of control equipment in either integrated consoles or free standing control panels, they are completely assembled, factory-fire-tested and backed by undivided responsibility.

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For more facts circle 247 on Reader Service card, p 103

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## Free literature

folder 2305-7. Hays Mfg Company, Automatic Controls Div

**140** **Shaft-position digital** encoders with magnetic readout are topic of 12-p booklet. Complete specs, operating principles are given. Electro-Mechanical Research, Inc, Ascop Div

**141** **Speed-recording system** is announced in 8-p bulletin 260. Description of use of speed relays to protect belt conveyors is included. The Esterline-Angus Co

**142** **Multipoint recorder** permits you to change from 2 to 24 points in seconds. Details are in specification sheet 153-23. Minneapolis-Honeywell Regulator Co

**143** **Technique of** obtaining effective damping in structures, damped test fixtures are explained in 4-p folder. Barry Controls, Inc

**144** **Thermocouple components** are described in specification FS005-3. Minneapolis-Honeywell Regulator Co

**145** **Tube-rolling torque** control is covered in 2-p data sheet AC 7-A. The Gustav Wiedeke Co

**146** **Flame photometer** which measures chloride-ion content of boiler feedwater is topic of 4-p bulletin. Water Associates

**147** **Portable** temperature potentiometers with single and double ranges are described in 2-p data sheet ND42-33(1A). Leeds & Northrup Company

**148** **Instructions** for using firm's temperature-sensitive crayons with calibrated melting points, *Tempilstiks*, are given in data sheet. Tempil Corporation

**149** **Instruments** for industry are covered in well-illustrated bulletin 19-60. All of firm's major lines are described. James J Biddle Company

**150** **Resistors, rheostats** and potentiometers are presented in 8-p bulletin 260. Specs, sizes, ratings are given. Hardwick, Hindle, Inc

**151** **Flow transmitters** extract square-root function producing signal varying linearly with rate of flow. Details are in spec sheet P22-1. Bailey Meter Company

**152** **Gaussmeter** is introduced in 2-p spec sheet. Operating principle, features, applications are given. F W Bell Inc

**153** **Pyrometer** for precision temperature measurements is topic of catalog 175. Power Instrument & Control Supply Corporation


For more facts circle 248 on Reader Service card, p 103

Begins on page 104

**154** **Pressure gages** for oil, water, steam, gas are covered in folder DH-333. American Chain & Cable Co, Inc, Helicoid Gage Div

**155** **Draft regulator,** electric-power unit for combustion and process control and master regulator for boiler-steam-pressure control are topic of bulletins H-109, H-110, H-111. Rimcor Products, Inc

**156** **Explosionproof illuminator** for liquid-level gages, features and sizes are presented in 2-p data sheet 375. Jerguson Gage & Valve Company

**157** **Miniature gages,** vertical type with 5-in. scales for measuring and indicating draft, pressure, differential pressure, temperature and pneumatic signals are described in 12-p bulletin 59-1. Scales, ranges, mounting dimensions and lighting details are given. Republic Flow Meters Company

### WELDING

**158** **Aluminum welding,** brazing and soldering is included in 40-p manual. Charts on composition of aluminum alloys, chapters on aluminum brazing, latest arc- and gas-welding processes are included. All-State Welding Alloys Co, Inc

**159** **Air-cooled electrode** holder for heavy-duty metallic arc welding is described in data sheet. J B Nottingham & Company, Inc

**160** **Tube and fitting welder,** *Mark II,* is featured in 4-p bulletin. Cyci-O-Magic Incorporated

### LUBRICATION

**161** **Solid-film lubrication** and protective-coating process is described in 4-p brochure. The Almasol Corporation

**162** **Oil-mist-lubricating system** for single- and multiple-point spraying is covered in report 24. Oil-Rite Corporation

### MAINTENANCE

**163** **Pipe-marking device** is announced in 4-p bulletin. Price info is included. Tool and Equipment Company

**164** **Aluminum grating** for flooring, other applications is introduced in 4-p brochure. Weights and types are charted. Kerrigan Iron Works Company

**165** **Conditioner** to keep spray guns ready for use is described in folder. Wisconsin Laboratories, Inc

continued on p 112


no more knuckle-busting . . .

New RIDGID No. 450

Portable Tristand Chain Vise

Capacity, ⅛" to 5"
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Here's a real time saver. Not only do you get a complete workbench that's truly portable, but now you get a chain vise that's extra easy and fast to operate. Handle is right up on top where it's always handy. Handle and tightening nut are anchored to vise base . . . can't pull out.

Vise base, that overhangs front legs for clear tool swing, has hanger slots for tools, 3-size pipe bender, rear pipe rest and adjustable ceiling brace screw. Folding legs and integral tray set up easily and lock in position for rigid work base. Snap chain holds folded legs closed for easy carrying . . . no loose parts. Rubber grommets in tristand feet prevent creeping. See and try this more-for-your-money RIDGID Top Screw Chain Vise at your Supply House!

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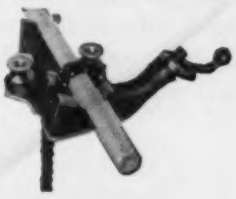
5 Sizes for ⅛" to 8" Pipe, Conduit or Rod



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King-sized capacity of these cars means the N&W can deliver your coal faster, more efficiently. Advanced design of the big new hoppers will give them a life span of 5 years more. They start rolling from N&W shops in August, with deliveries completed by the end of the year!

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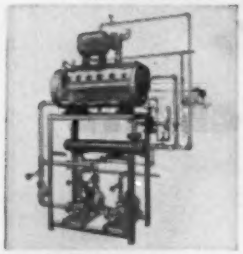
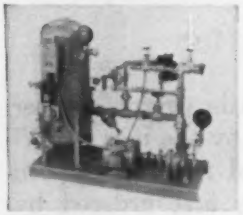


**ZERO-OXYGEN DEAERATING SYSTEMS**
Guaranteed oxygen removal to .005/cc liter under 10-to-1 load swings, up to 250,000 lbs./hr. Other deaerators for smaller needs.



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Continuous steam and air removal eliminates steam traps and drainage device maintenance.

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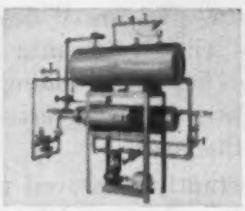
*For instance,* you may need a complete condensate handling and deaerating system, starting with outlying condensate return units discharging to a central surge tank. *Plus* transfer pumps with sequence controls to feed the deaerator itself. Finally boiler feed pumps and the controls to make the whole system work — with any degree of automation you require.

**2. SCHAUB WILL ENGINEER AND DELIVER** you such a system — or any part of it — and underwrite its continuous performance. All components are "phased-out" to work together as an integrated and balanced whole.

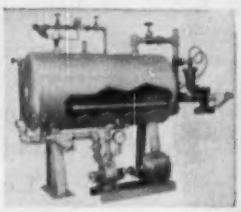
**3. OR WE WILL SUPPLY** you with individual packaged units — from pumps to console blowdown systems — to expand, augment or improve an existing system.

***This is what we mean*** by Schaub "one-source" responsibility. From concept, through design to installation and service, you go best when you go Schaub — *all the way.* Hundreds of Schaub owners and engineers agree!

**PACKAGED CONTINUOUS BLOWDOWN SYSTEMS**
Automatic flash heat recovery, timer flush, sample cooling, drain after-cooling, high level shutdown, for any number of boilers.



**HEAT RECLAIM SYSTEMS**
Save about 10% on fuel with large percentage high pressure return systems.



**PREE-HEET SYSTEMS**
Stretch boiler capacities during peak loads while maintaining optimum pressures. Prolong life of boilers and return lines.

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## Free literature

Begins on page 104

### MECHANICAL POWER TRANSMISSION

**166** **Industrial V-belt-design** catalog features easy pre - engineered tables. Selection tables, hp ratings, product info are included in this 64-p catalog. Boston Woven Hose & Rubber Company

**167** **Variable-pitch sheaves** and motor bases for 1/6- to 2-hp drives are subject of 8-p bulletin SL-101-A. Browning Mfg Company

### MATERIALS HANDLING

**168** **Permanent magnetic pulleys** for automatic separation of large- or small-iron contamination are announced in selection guide. This recommends models for each type of application. Chart lists belt width, capacity, weight, dimensions. Eriez Manufacturing Co

**169** **Selection of** electromagnetic pulleys or nonelectric ceramic type pulleys is explained in catalog C-2000. Newly developed ceramic magnet material is described. Dings Magnet Separator Co

### PUMPS

**170** **Vertical wet-pit pumps** with capacities to 200,000 gpm are topic of 6-p booklet 7209-A. Ingersoll-Rand Company, Hydraulics Div

**171** **Seal-less pumps** for leakproof handling of volatile, toxic liquids are covered in 4-p bulletin 728.1. Goulds Pumps, Inc

**172** **Electric-powered** centrifugal pumps are described with specs in bulletin CPE-1-27. Rice Pump & Machine Company

### SAFETY EQUIPMENT

**173** **Nonsparking safety tools** are described in report Pb-151650. Ampco Metal, Inc

**174** **Fire-retardant paints** and how they work are described in 12-p booklet 100. Albi Mfg Co

**175** **Classes of fires** and portable extinguishers to be used on each are presented in chart AD3003R8. Walter Kidde & Company, Inc

**176** **Safety enclosures** for handling chemical and radioactive materials are introduced in data sheet. S Blickman, Inc

**177** **Fire-protection pumps,** portable, self priming, centrifugal, are presented in 2-p brochure. Rice Pump & Machine Company

### PRIME MOVERS

**178** **Turbocharged gas engine,** 2 cycle, V type designed as high-hp

# CRACK THE PROBLEM OF HANDLING NEXT WINTER'S FROZEN COAL—NOW!

## Pennsylvania's Frozen Coal Cracker is the answer

If frozen coal handling is one of your winter problems—you can solve it with a Pennsylvania Frozen Coal Cracker.

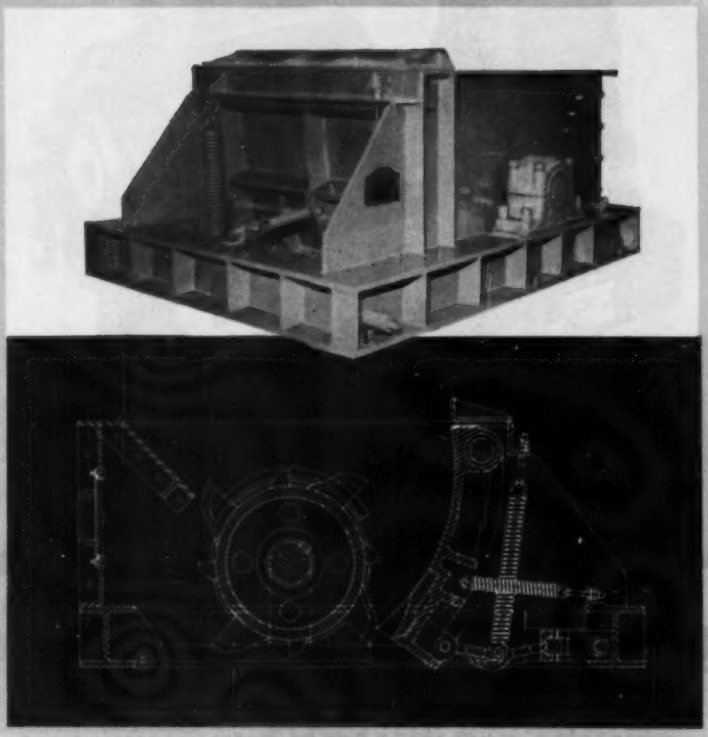
This is the specially-developed cracker with a *wide feed opening*, permitting use of *open-throated* hoppers. Dumped directly into such hoppers (no need for grates) the frozen masses of coal work their way freely to the hopper bottom where they are broken up by blows from the cracker's special teeth.

A uniform product with limited top size and minimum fines is fed conveyors, protecting them from overload, and insuring a continuous flow of coal from unloading point to yards, or yards to plant.

Cracker can be started up with full hopper; operates satisfactorily under choke feed.

Breaker plates are designed so that in warm weather they can be opened up, permitting the coal to pass through without operating the crusher.

Mechanically simple, built-in tramp iron protection. Low headroom required makes the Frozen Coal Cracker ideal to fit into existing hoppers. Drives can be engineered to fit in a minimum of space. Capacities up to 1200 tons per hour. Available in single or twin units.



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Don't be plagued by hopper jams, overloaded conveyors, slowdowns and high labor costs. Act now. Write for new Bulletin 2013.

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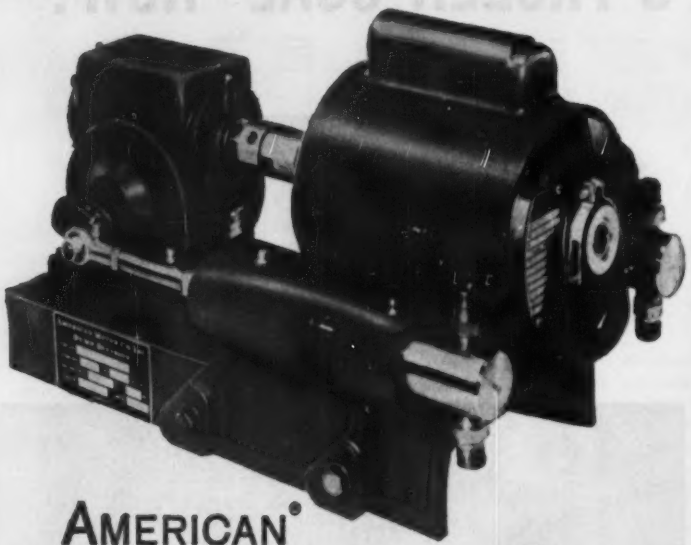
For more facts circle 252 on Reader Service card, p 103

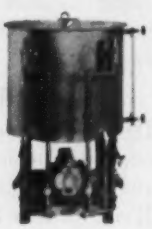
# FEED CHEMICALS ACCURATELY!



AMERICAN®
METERING PUMPS

Series 100 pumps have repetitive metering accuracy of plus or minus 1% when operating between the limits of 10% and 100% of stroke length. Design simplicity assures dependable, economical water treatment. Screw adjustment on crank provides easy, accurate stroke regulation for capacities ranging from .65 gph to 13.10 gph at maximum pressure of 1000 psi on Series 100 Simplex model. Duplex models have double that capacity.

- interchangeable liquid ends
- spherical self-aligning bearings on crank and crosshead handle greater radial and axial thrust loads
- crossheads of hardened and ground steel ride on cast iron
- easily adjusted screwed packing glands
- heavy duty reducers
- NEMA frame motors
- nylon dust covers protect bearing surfaces



Available with standard feeder tanks of various sizes.

AMERICAN® METER COMPANY
INCORPORATED (ESTABLISHED 1836)
pump division
13500 PHILMONT AVE., PHILADELPHIA 16, PENNA.


## Free literature

Begins on page 104

driver for centrifugal pipeline compressors, generators and liquid pumps, is featured in 26-p bulletin 176. Design features, operating advantages are fully illustrated. Clark Bros Company

**179** **Ultra-lightweight** gas turbines with 75- to 20,000-hp rating, 300-lb weight are covered in 8-p brochure GEA-7083. General Electric Company

### VALVES, PIPING FITTINGS AND SPECIALTIES

**180** **Corrosion-resistance-rating** guide for metals, plastics, synthetic rubbers used in valves lists 390 different fluids with corrosive effects. Hydromatics, Inc

**181** **Motorized valves,** electric motor operators are described with valve features, specs in 24-p catalog 407. Dimensions, weights, data are given for each model. Schade Valve Mfg Company

**182** **Valve catalog** is completely revised 16-p edition, lists specs, characteristics, sizes, ratings, firm's line in various materials. American Chain & Cable Co, Inc, R-P&C Valve Div

**183** **Tilting-disk check valves,** 1-piece cast-steel type, are featured with ratings, flow-index table, curves, valve-material specifications listed in 12-p catalog 14-Y. Edward Valves, Inc

**184** **Relief valves** for automatic relief of overpressure in steam, air and gas systems to 250 psig are topic of publication 5200-A. Cochrane Corporation

**185** **Butterfly valves,** resilient-seated type, and valves for corrosion resistance are featured in 4-p bulletin 590X and bulletin 802D. W S Rockwell Company

**186** **Fiberglass pipe-fitting** insulation is described in brochure TD-105. Design features, dimensional data, specs are given. Pall Corp

**187** **Rubber expansion joints** and flexible pipe are covered in catalog 850. General Rubber Corp

**188** **Flexible hose** for steam transmission is covered in 4-p booklet including six tables of order numbers, types and sizes to aid selection. Titeflex Inc

**189** **Tubing** capable of carrying internal pressures of 15,000 to 100,000 psi is topic of data sheets 22. Superior Tube Company

**190** **Critical piping** for nuclear age is title of 24-p brochure describing

## will be equipped with ANCHOR RUBBER EXPANSION JOINTS

LITTLE GYPSY — first computer controlled electric power plant — will be equipped with Anchor Rubber Expansion Joints.

This new plant of the Louisiana Power & Light Company selected Anchor Rubber Expansion Joints to insure trouble free operation in the water piping system.

Anchor Rubber Expansion Joints will solve your problems of vibration, expansion or contraction in air, gas, water, oil and chemical lines.

Select Anchor first for your plant; whether it be Rubber Expansion Joints or Mechanical Packings and Gaskets.

DISTRICT OFFICES

| | | |
|---|---|---|
| BALTIMORE, MD. | HOUSTON, TEX. | PHILADELPHIA, PA. |
| BOSTON, MASS. | INDIANAPOLIS, IND. | PITTSBURGH, PA. |
| BUFFALO, N.Y. | LOS ANGELES, CAL. | SAN FRANCISCO, CAL. |
| CHICAGO, ILL. | MILWAUKEE, WIS. | SEATTLE, WASH. |
| CINCINNATI, OHIO | MINNEAPOLIS, MINN. | SPOKANE, WASH. |
| CLEVELAND, OHIO | MONTREAL, CANADA | ST. LOUIS, MO. |
| DAYTON, OHIO | NEW ORLEANS, LA. | TOLEDO, OHIO |
| DETROIT, MICH. | NEW YORK, N.Y. | WILMINGTON, CAL. |

Find it Fast in the Yellow Pages

## THE ANCHOR PACKING COMPANY

GENERAL OFFICES . . . PHILADELPHIA, PENNSYLVANIA

FACTORIES . . . MANHEIM, PA., ELKHART, IND., MONTREAL, CAN.

FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

For more facts circle 254 on Reader Service card, p 103

# Would you start a trip without a spare?

That's the question we always want to ask when we get a feverish phone call from one of the thousands of operating men who have McDonnell No. 150 or No. 157 Controls on their boilers. The boiler is down . . . all because that veteran control after many years of service needs a small replacement . . . just a mercury tube, for instance. How fast can we get it to them? How the heck do they go about putting it on? . . . and so on and on.

When these calls come in we have an answer that immediately puts the caller back in good humor. We tell him his jobber can get him a complete replacement mechanism that will clear up his trouble in minutes, and then send us the original mechanism which we will rebuild and return. In this way the job will be protected from any such dilemma from then on.

All right, there's good news for any of you operating men who have a McDonnell No. 150 or No. 157 Control. Don't wait till it happens; be ready for it. Have an extra head mechanism on hand — a *spare*. Getting small parts takes time; putting them in is slow work. The loss of steam and plant activity can cost a lot of dollars. So compared to the possible loss, the cost of a spare head mechanism is insignificant. The story is told and pictured alongside.

***Remember: It's the fellow without the spare who gets the flat!***

**Ask for facts...**

**McDONNELL & MILLER, Inc.**
**3506 North Spaulding Avenue**
**Chicago 18, Illinois**

**McDONNELL**
*Boiler Water Level Controls*
*Doing One Thing Well*

***If you have a McDonnell No. 150 or 157 Pump Control — Here's a trick that can save you worry and dollars***

1

**If something goes wrong** just disconnect wiring and take out 8 Cap Screws to remove original mechanism.

**Time required:** A few minutes!

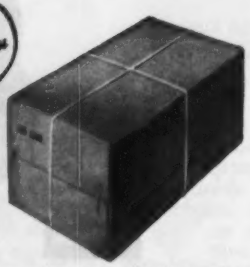
*150-HD Automatic Reset Control*
*150M-HD Manual Reset Control*

2

**Replace it with spare mechanism** which you have on hand and connect wiring.

**Time required:** A few minutes!

*Your Jobber Stocks Them*



3

**Have original mechanism sent to us.** It will be completely factory rebuilt and returned promptly. So . . . . . ***you always have a spare on hand.***


## Free literature

Begins on page 104

firm's facilities for fabrication and erection of nuclear pipe and manufacture of fittings. Midwest Piping Company

**191** **Valves for air,** oil, water, gas, chemical or vacuum service are described in bulletin 91023. Airmatic Valve, Incorporated

**192** **Fluid filter elements,** wire-cloth type, are described in 4-p brochure 142. Fluids and systems which can be used with these filters are listed. Bendix Aviation Corp, Bendix Filter Div

**193** **Gaskets for flanges,** joints, boiler manholes, furnace doors are featured in 12-p catalog. Greene, Tweed & Company

**194** **Diaphragm seals** for protecting pressure instruments from corrosion and clogging are topic of bulletin 250. Brooks Rotometer Company

### WATER TREATMENT

**195** **Results of** 8-yr corrosion tests on wrought iron and ten structural steels in salt- and lake-water environments are contained in 12-p report. A M Byers Company

**196** **Multiple-surface filters** with porous stainless-steel elements are subject of 8-p bulletin. Pall Corporation, Micro Metallic Div

**197** **Filters** and filter elements are described in 4-p bulletin M-213A with listing of stock and nonstock filters and elements. Pall Corporation, Micro Metallic Div

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EDITOR'S NOTE: *The following bulletins may be requested directly from manufacturer. Write on company letterhead to addresses below*

★ **Mechanical motor drives** with variable speeds are detailed in 96-p catalog of firm's complete line. Modifications and accessories of units with capacities from ¼ to 40 hp, range from 2:1 to 10:1 are explained. Reliance Electric and Engineering Co, Reeves Pulley Div, 24701 Euclid Ave, Cleveland 17, Ohio

★ **Motor controls** are topic of 162-p digest including prices, technical info on firm's complete line. Quick-reference-selector guide is given. Allis-Chalmers Mfg Co, Milwaukee 1, Wis.

★ **Pneumatic engineering manual** of general info is ideal reference. Use of air power, air-system installation, properties of air are some topics covered. This should be an aid when installing air-powered equipment. Wilkerson Corporation, 1601 W Girard Ave, Englewood, Col.

recipe for profit
Westinghouse
motor control recipe:
provides extra value with...
reserve capacity,
reliable operation,
matched to the job
performance
YOU CAN BE SURE... IF IT'S Westinghouse

TESTED RECIPES FOR PROFIT . . .

# Westinghouse blends "hidden" ingredients in extra value controls for profitable plant operations

- Quality control
- Design ability
- Quality components
- Application experience
- Manufacturing know-how
- Maintenance facilities
- Extensive research

How does Westinghouse handle this basic control recipe to make the result superior to any other? The best chef knows that the quality of the ingredients used and the mixing knack account for the blue-ribbon winners.

At Westinghouse, highest quality control components plus a large portion of expert manufacturing skill, craftsmanship and experienced know-how are carefully blended. Such "hidden" ingredients mean industrial motor controls with reserve capacity to handle overloads . . . long, trouble-free service . . . and performance custom-matched to your needs. Qualities that give **more control value for your money.** Qualities more than sufficient to meet today's demands for extraordinary reliability. That's why it pays to look beneath the surface of any control to be sure you are getting Westinghouse quality.

Your local Westinghouse representative is ready with a wide selection of industrial motor controls. Ask him to tell you more about their **hidden values** . . . benefits by the baker's dozen . . . for more profitable plant operations.

The proof of Westinghouse controls is in their using!

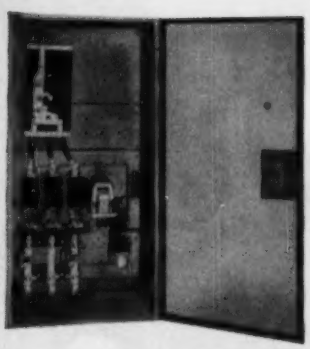
Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

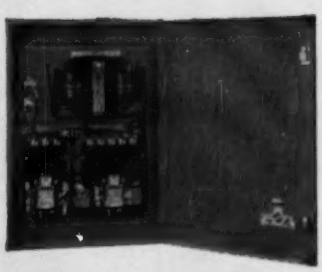
**YOU CAN BE SURE...IF IT'S Westinghouse**

TUNE IN WESTINGHOUSE-CBS TV RADIO COVERAGE, PRESIDENTIAL CONVENTIONS, JULY 10-29

**For more facts circle 256 on Reader Service card, p 103**

Check your favorite chef's best dish. The recipe calls for the finest ingredients. However, real success comes from devoted attention to details. Superior product quality, likewise, requires premium components and craftsmanship.





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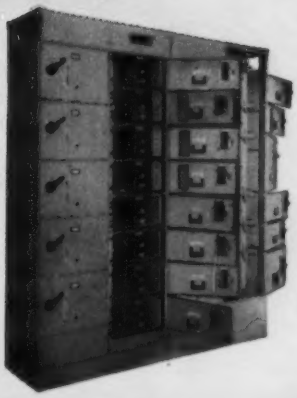


## Control Centers

Compact grouping of all motor controls
cuts installation time;
frees production areas;
permits easy one-man
control supervision;
speeds maintenance and service.

Interchangeable modular construction.

## Life-Line® Starters

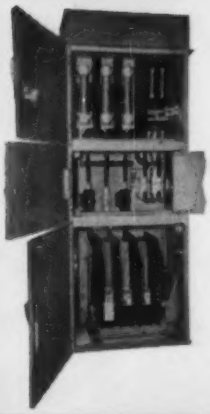
Full-voltage, a-c magnetic starters in all NEMA enclosures.

Time-tested components . . . straight-through wiring, front-accessible parts combine to slash installation and maintenance costs.

proved De-ion® arc quencher increases contact life . . .
silver plated interchangeable contacts . . . clapper-type operating mechanism . . . smaller compact designs.

Single phase or polyphase; up to 600 volts — reversing or non-reversing;

Non-combination or combination with disconnects or circuit breakers.



## Ampgard® High-Voltage Starters

Maximum protection for motors, systems and personnel.

Faults interrupted in less than ½ cycle . . . isolates fault to prevent shutdown of other equipment.

Completely front accessible.

Externally operated line isolating switch.

Exclusive mechanical and electrical interlock . . . prevents switch operation under load; automatically stops motor when cabinet is open.

Full line available . . .
for squirrel-cage, wound-rotor and synchronous motors up to 3000 hp — up to 5000 volts.

® Trade-Mark

## Reduced Voltage Starters

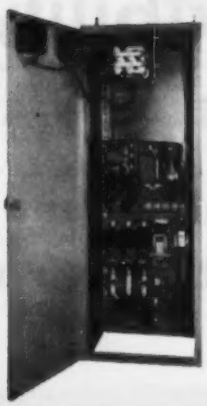
Widest possible selection of primary resistor, auto-transformer, part-winding and star-delta types for squirrel-cage, wound-rotor and synchronous motors in all hp ratings — up to 600 volts.

Manual and magnetic starters to provide the proper starting characteristics for any application.

Available with integral circuit breaker or disconnect switch — fused or non-fused.

Enclosures available for every need . . .
general purpose . . . dust-tight industrial . . .
watertight . . . explosive atmospheres.

**Available for immediate delivery.**



## Static Slipsyn® Synchronous Motor Control

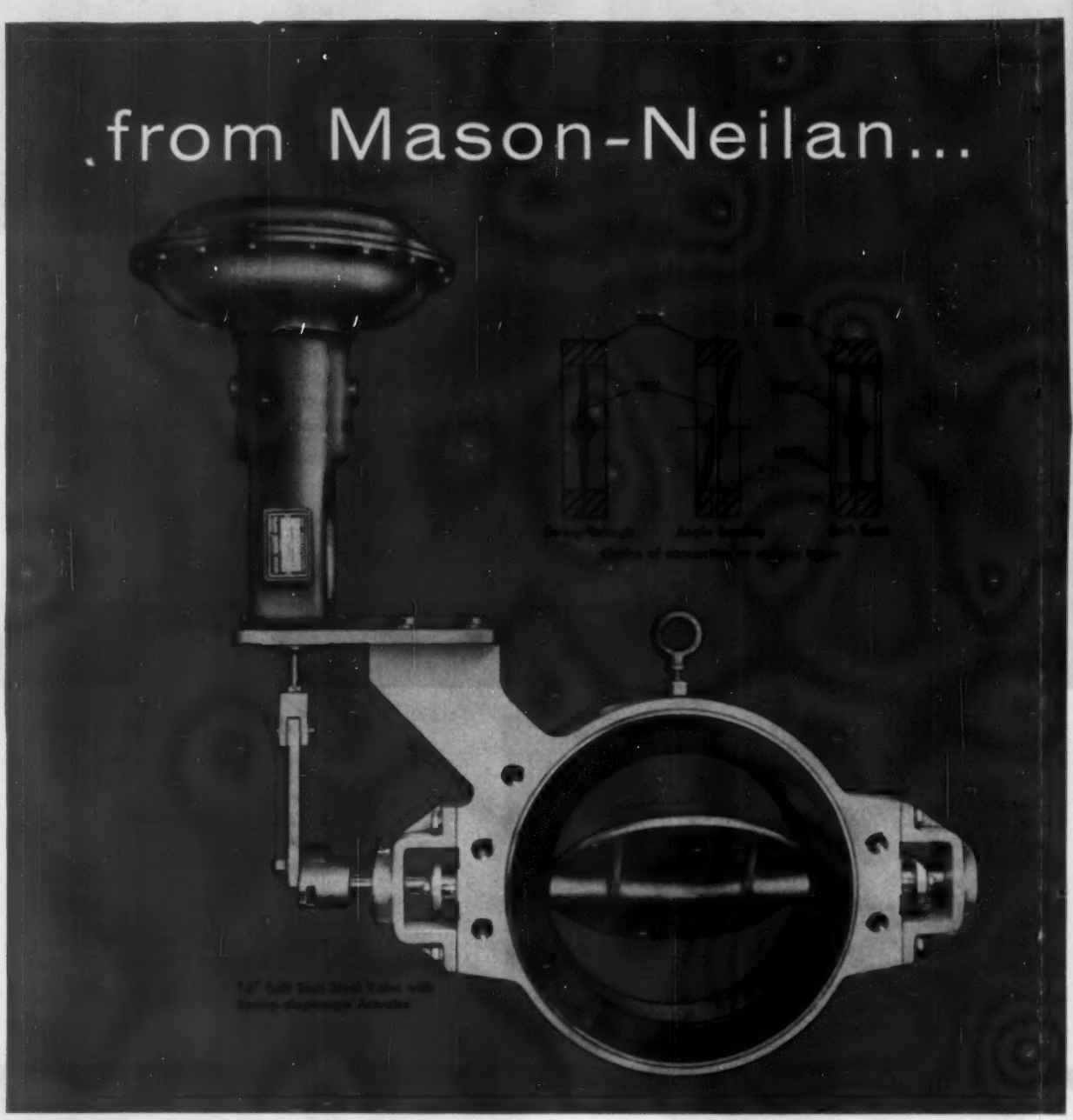
Static transistor circuit guarantees . . . maximum reliability and accuracy; no moving parts to wear, corrode or fail; unaffected by contaminated atmosphere.

Motor field excitation applied at precise speed and pole position.

Adjustable pull-out protection, permits immediate detection or delays action to eliminate false tripping caused by transients.

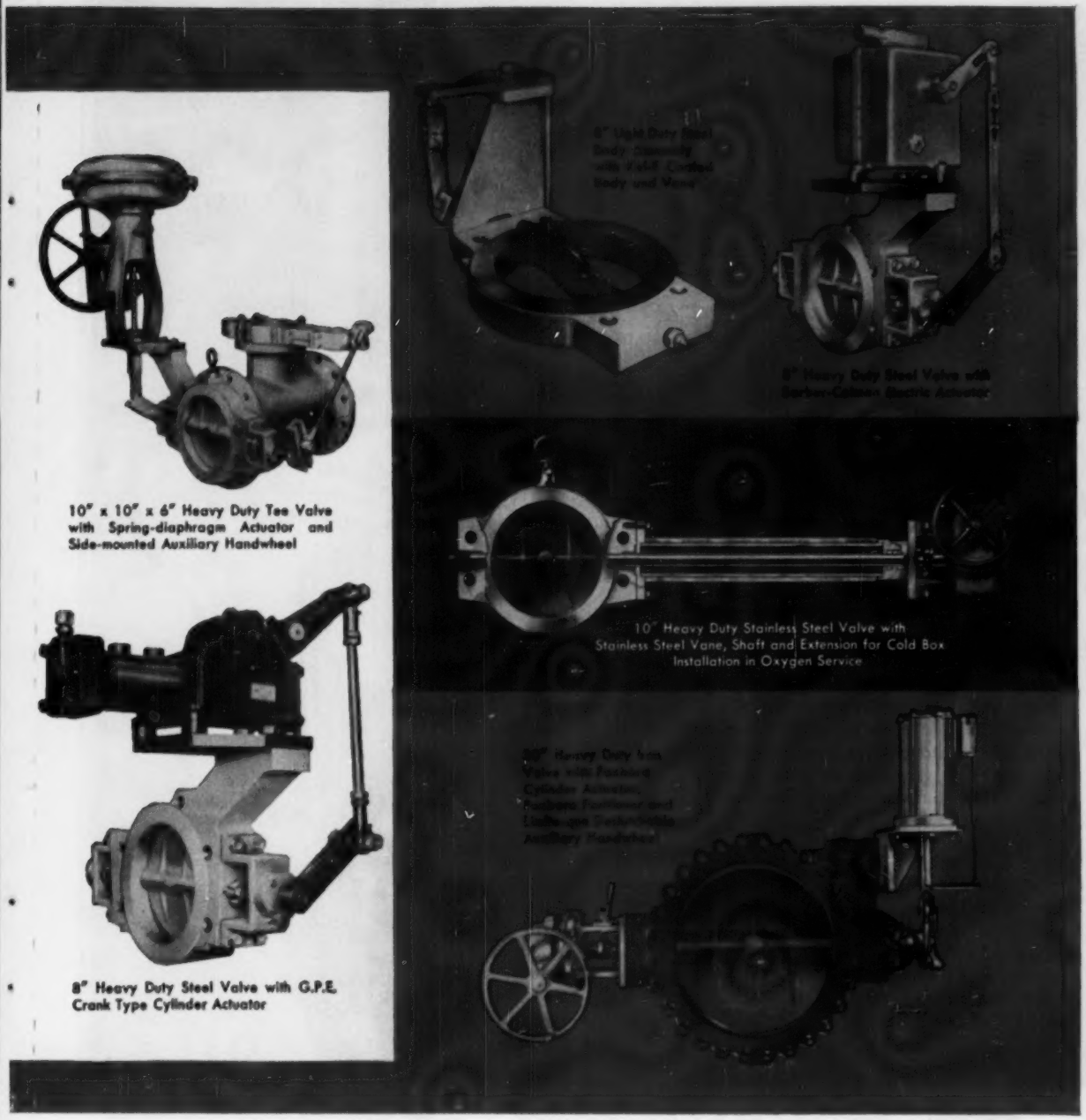
Available as complete starter or field conversion unit for **any make** control!

from Mason-Neilan...



# Flexibility in Butterfly Valve Application

***With Wide Selection of Actuators, Choice of Swing-through or Seating Types***



10" x 10" x 6" Heavy Duty Tee Valve with Spring-diaphragm Actuator and Side-mounted Auxiliary Handwheel

10" Heavy Duty Stainless Steel Valve with Stainless Steel Vane, Shaft and Extension for Cold Box Installation in Oxygen Service

8" Heavy Duty Steel Valve with G.P.E. Crank Type Cylinder Actuator

Mason-Neilan offers a broad line of butterfly valves with a choice of nonseating, angle seating, or soft seat wafer bodies and a wide variety of power and manual actuators.

The few typical examples shown here are indicative of the scope of the Masoneilan line. These, and the many other variations available, exemplify the quality and design features resulting from over 75 years of experience in valve manufacturing.

For control of large volumes of liquids or gases, select Masoneilan Butterfly Valves. Complete information on request, ask a Mason-Neilan representative or write to:

**MASON-NEILAN**

*Division of Worthington Corporation*

**33 NAHATAN STREET, NORWOOD, MASS., U. S. A.**

*Sales Offices or Distributors in Principal Cities in United States and Abroad*

In Canada: Worthington (Canada) Ltd., Mason-Neilan Division

MASONEILAN



For more facts circle 257 on Reader Service card, p 103

# Modern use of coal cuts fuel costs 22%

## In addition, coal costs Uniontown Hospital $3.00 per ton less than gas!

**Expansion of facilities at Uniontown Hospital, Uniontown, Pa., increased the demand for steam used for space heating, water heating, kitchen, laundry and sterilizing equipment. An engineering survey was conducted which indicated the need for a new plant rather than modernization of the old one. Hospital officials —working with Altman and Altman, Architects, and Paul S. Park, Consulting Engineer—decided to install a completely automatic steam plant. Coal continues to be used because it meets the hospital's rigid standards for cleanliness and has proved the most economical fuel. Not only has burning coal this modern way shown a 22% savings in fuel costs compared to the old plant but, per equivalent ton, coal actually costs $3.00 less than its nearest competitive fuel!**

### COAL IS LOWEST COST FUEL

Today, ***when the annual cost of fuel often equals the original cost of the boilers,*** you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% more steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

### CONSULT AN ENGINEERING FIRM

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

### TECHNICAL ADVISORY SERVICE

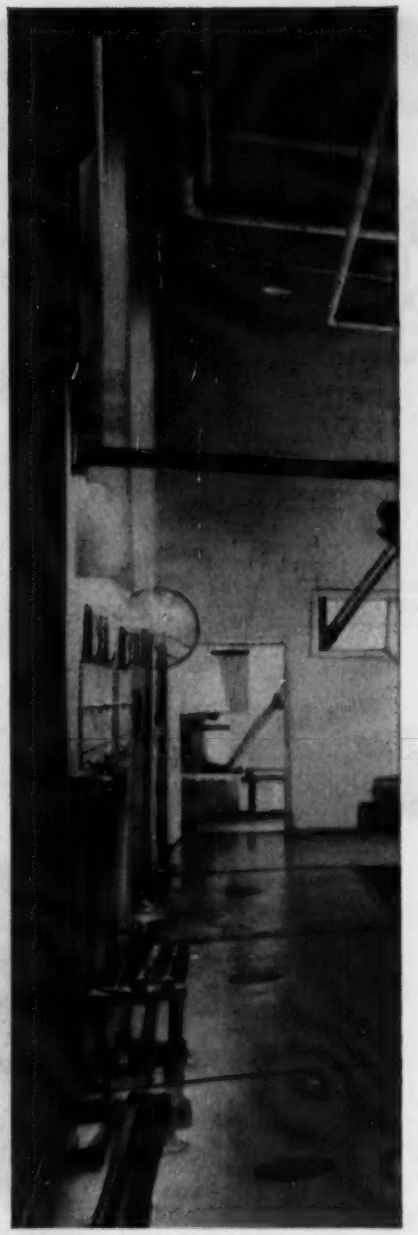
To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

## BITUMINOUS COAL INSTITUTE

A DEPARTMENT OF THE NATIONAL COAL ASSOCIATION

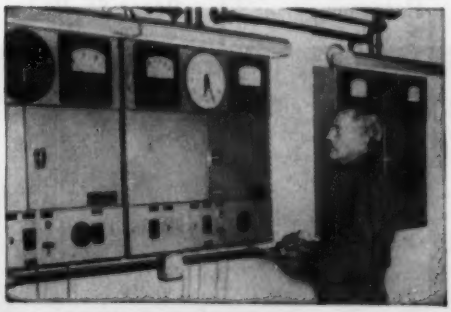
Dept P06, Coal Bldg., 1130 Seventeenth St., N W., Washington 6, D. C.

*See our listing in Sweet's Files: A-30J/Bi; PE-4a/Bi; IC-18b/Bi*



Coal is discharged into bin and gravity fed into hopper box, then moved by inclined screw conveyor into horizontal screw conveyor leading to stoker hoppers and boilers. Boilers are Keeler 10,000 lb/hr "CP" type units, 150 psi. Coal handling system by Auburn Foundry Company.

The completely enclosed electric-type combustion control panel (Cleveland Controls, Inc.) contains assembly units for all power control and coal handling operations. Steam flow meters, strategically located throughout the hospital, enable the operating personnel to determine any variable in load conditions.




**SEND COUPON FOR NEW BCI PUBLICATIONS**
Guide Specifications, with complete equipment criteria and boiler room plans:

Bituminous Coal Institute, Coal Building,
1130 Seventeenth St., N.W., Washington 6, D.C.

Gentlemen: Please send me: P 86

- ☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker).
- ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker).
- ☐ GS-3 (automatic package boiler for heating and process plants).
- ☐ Case histories on larger plants.

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____



**For more facts circle 258 on Reader Service card, p 103**

**Circle 259 on Reader Service card for following ad ➤**

# HERE'S WHY BEACON COAL

## WHEN—WHERE—

| Name of Coal | Character | Mine | Seam | County & State |
|---|---|---|---|---|
| Sonman | Central Pennsylvania Low Volatile | Sonman | "E" | Cambria (Pa.) |
| Colver | | Colver | "B" | Cambria (Pa.) |
| Indian Creek | Central Pennsylvania Medium Volatile | Melcroft | "B" or Miller | Fayette (Pa.) |
| Federal | Northern West Virginia | Federal #1 | Pittsburgh | Marion (W. Va.) |
| Beckley | Southern West Virginia Low Volatile | Eccles #5 | Beckley | Raleigh (W. Va.) |
| Sewell | | Eccles #6 | Sewell | Raleigh (W. Va.) |
| New River | | Stotesbury #8 | Pocahontas #4 | Raleigh (W. Va.) |
| | | Stotesbury #10 | Pocahontas #4 | Raleigh (W. Va.) |
| | | Stotesbury #11 | Pocahontas #4 | Raleigh (W. Va.) |
| Pocahontas | | Keystone | Pocahontas #3 | McDowell (W. Va.) |
| Eagle | Southern West Virginia and Eastern Kentucky High Volatile | Beards Fork | Eagle | Fayette (W. Va.) |
| | | Kopperston #1 | Eagle | Wyoming (W. Va.) |
| No. 2 Gas | | Kopperston #2 | Campbells Creek | Wyoming (W. Va.) |
| Wharton | | Wharton #1 | Hernshaw | Boone (W. Va.) |
| | | Wharton #2 | Hernshaw | Boone (W. Va.) |

As this chart shows, there is a Beacon Coal suited to every fuel need: Domestic or Commercial; Hand or Stoker Firing; General Industrial; Electric Utility; Railroad; Coke or Gas Plants; and Special Uses. Mine Locations and shipping facilities permit speedy, efficient deliveries, and conveniently located sales offices mean that there's a Beacon Representative ready, in almost every area, to serve you.

If you would like a copy of this chart for reference—just write or phone the office nearest you.

EASTERN GAS AND FUEL ASSOCIATES — BEACON COAL

**EASTERN**

PITTSBURGH
Koppers Building

# CAN GIVE YOU THE COAL YOU NEED

## AND AS YOU NEED IT!

| Railroad | District | Sizes Made | Daily Prod. Tons | Name of Coal |
|---|---|---|---|---|
| Penna. | 1 | Egg; Stoker; M/R; N&S; Slack | 2500 | Sonman |
| C & I | 1 | N&S; Slack; Stoker; Nut | 5000 | Colver |
| B & O | 1 | M/R; N&S; Slack | 1200 | Indian Creek |
| Monongahela; B&O | 3 | Lump; Egg; Nut; Stoker; M/R N&S; Slack | 12,500 | Federal |
| C & O; N & W | 7 | Scr. M/R; Stove; N&S; Slack | 2500 | Beckley |
| C & O; N & W | 7 | Scr. M/R; Stove; N&S; Slack | 1000 | Sewell |
| C & O; N & W | 7 | Stoker; M/R; Slack | 2000 | New River |
| C & O; N & W | 7 | Stoker; N&S; Slack | 2500 | |
| N & W | 7 | M/R; Slack | 1800 | |
| N & W | 7 | Egg; Stove; Nut; Stoker; M/R; N&S; Slack | 7500 | Pocahontas |
| N & W | 7 | M/R; N&S | 2900 | Eagle |
| N & W | 8 | M/R; N&S; Slack | 3500 | |
| N & W | 8 | M/R; Nut; N&S; Slack | 7000 | No. 2 Gas |
| C & O | 8 | M/R; N&S | 3500 | Wharton |
| C & O | 8 | M/R; N&S | 4000 | |

# GAS AND FUEL ASSOCIATES

BOSTON 250 Stuart Street

CLEVELAND Terminal Tower Building

DETROIT 640 Stafford Road (Birmingham)

NEW YORK 60 E. 42nd Street

NORFOLK Citizens Bank Building

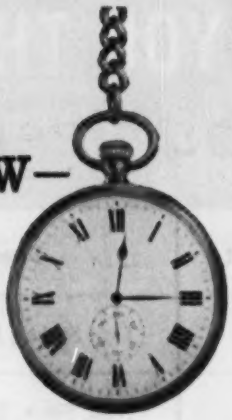
PHILADELPHIA Suburban Station Building

SYRACUSE State Tower Building

For New England: NEW ENGLAND COAL & COKE CO.

For Export: CASTNER CURRAN & BULLITT, INC.

# NOW—



# CHANGE VALVE TRIM IN 15 MINUTES

**New Leslie Cage Trim Control Valve is Designed for Today's Use and Tomorrow's Changes.**

Here's a control valve designed in steel and alloy steels that offers new assurance the valve you initially specify and install *will always fit an application*—even if changes in plans or future system changes might ordinarily call for complete valve replacement.

The new Leslie cage trim valve allows complete trim inspection in 15 minutes without removing the valve from the line. You can also switch valve action or size of actuator. Or, change valve characteristic or trim materials at will with an inexpensive interchangeable trim kit that reduces spare valve and valve parts inventories. Cage trim cuts maintenance and system modification costs to the bone—it's the kind of valve that makes foresight almost as good as "hindsight".

For sizing and capacity data on cage trim control valves, write for Bulletin or contact your Leslie Engineer—he's listed under 'Valves' or 'Regulators' in the Yellow Pages.

**Leslie Co., 701A Grant Ave., Lyndhurst, New Jersey**

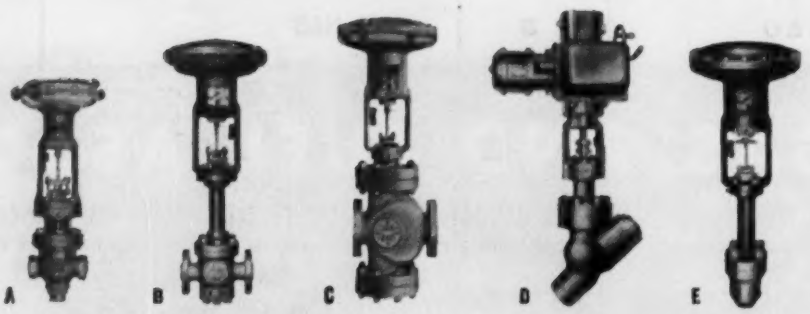
A Unbalanced valves up to 2500 lb ASA ratings.

B Piston balanced valves up to 600 lb ASA ratings.

C Double seated control valves to 600 lb ASA ratings.

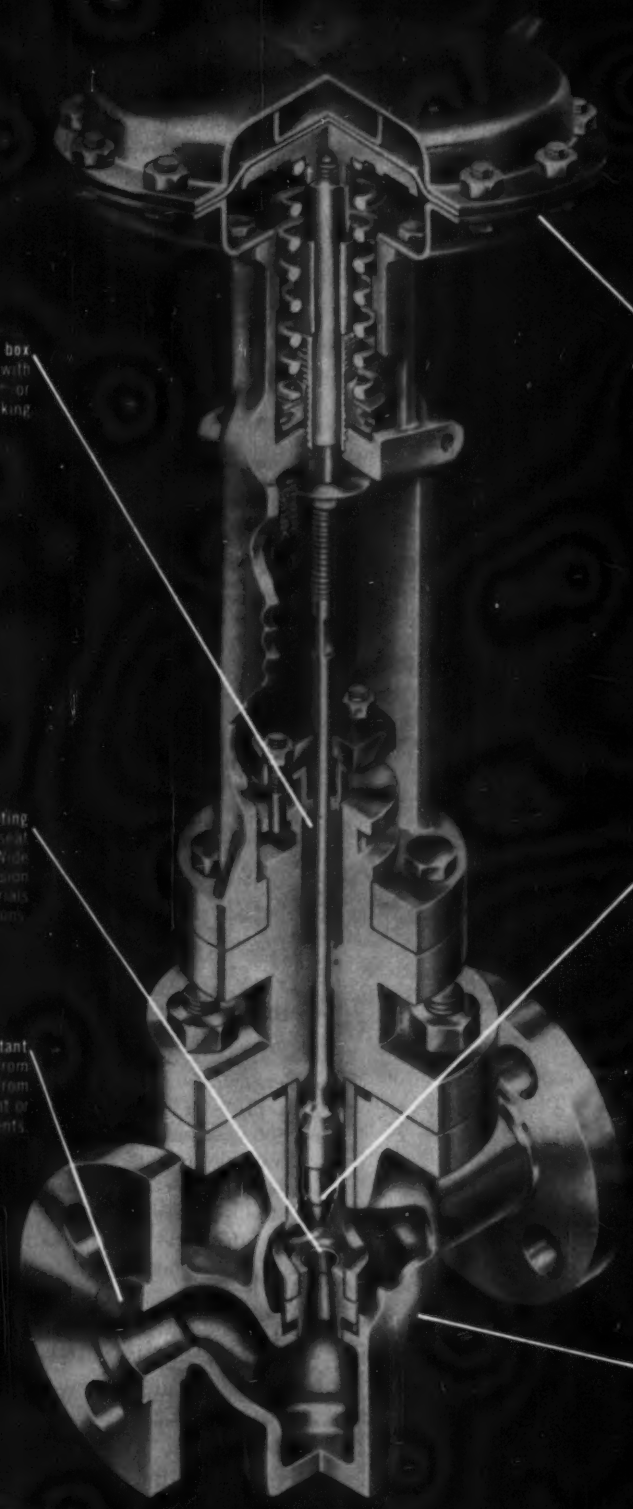
D High pressure-high temperature control valves.

E Angle body control valves.






For more facts circle 260 on Reader Service card, p 103



**Flanged, thru-bolted stuffing box** no lubricator needed with Leslie-Lubrisoft™ or Teflon V-Ring packing

**Actuators for normally open or normally closed valves** with 35, 55, 85 and 135 square inch effective areas

**Long-Life, Stellite seating** surface on renewable seat insert for steam service. Wide selection of alternate corrosion and erosion resistant materials for other applications

**Interchangeable inner valve** shapes and materials — choice of needle, plugs, V-port, quick opening, micro tapers

**Corrosion-erosion resistant materials** in ASA rating from 150 to 2500 lbs. Select from a wide line to meet present or future system requirements

**High Capacity Body** any end connections in ½ to 3" sizes

TRADE LESLIE MARK

# REGULATORS and CONTROLLERS

For more data on these developments, circle key numbers on Reader Service card, p 103

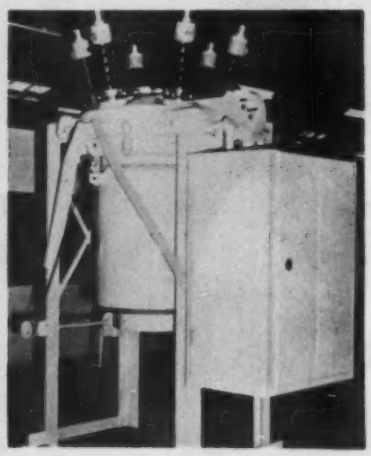
# Plant equipment news... Your

## High-capacity fuse offers full overload protection

1 • Low-peak fuses will safely interrupt fault current to 200,000 amp, limit let-through current to low values while giving full overload protection. Fuses will hold a 500% load for ten-second minimum.

Overload feature prevents blowing on motor-starting currents or other harmless overloads. Circuit can be fused close to full-load current without fear of needless blowing. Manufacturer's tests show fast opening of fuse on a heavy fault prevents building up a damaging peak value of current. In protecting circuit components against thermal and mechanical stresses, let-through current is restricted to safe values.

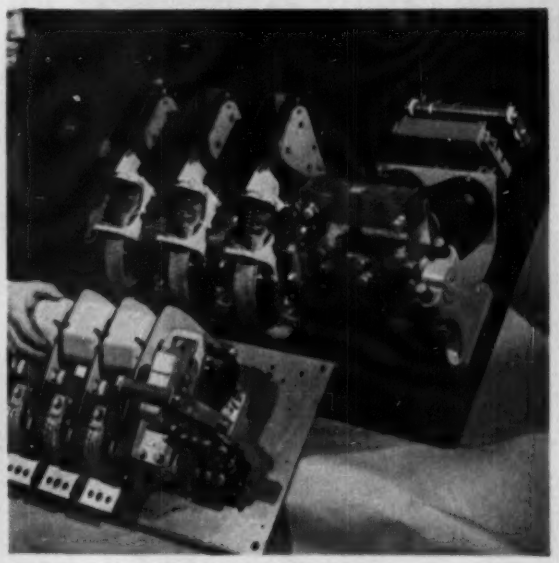
Available in a full range from 15 to 600 amp at both 250- and 600 v for installation in standard fuseholders, low-peak fuses are suitable for a wide field of application in new or existing installations, wherever both overload and high-capacity s-c protection is needed.—McGraw-Edison Company, Bussman Manufacturing Div



### One-tank breaker handles to 46 kv

2 • Single-tank oil breaker incorporates vertical interrupter which permits tank to safely contain all three phases. With subtransmission ratings of 14.4, 23, 34.5 and 46 kv, mva from 500 to 1500, breaker provides 5-cycle interruption and 20-cycle reclosing as standard performance. Adequate clearances, special tank liners and phase barriers insure protection, according to maker.

New design offers shorter arcing time, reduced oil contamination and contact erosion. Servicing only one tank, you save 30 to 80 gal of oil.—I-T-E Circuit Breaker Company, Kelman Power Circuit Breaker Div



### Contactor features small size, ac operation

3 • This 600-amp contactor for ac electric circuits is designed for continuous duty. Ac coils operate unit at 85 to 110% of rated coil voltage. Insulated for maximum of 600 v, contactor incorporates ac-operating magnet.

Available in 2- to 3-pole, front- or rear-connected assemblies with or without arc quenchers, unit will mount on steel. Built-in permanent air gap for evading magnetic path should insure positive dropout on de-energization.—Westinghouse Electric Corporation

### Regulator exciter operates to 25 amp, 130 v

4 • Voltage-regulator-exciter regulates output voltage of any 60-cycle generator or exciter requiring full-load dc field supply of 10 to 25 amp at 130 v or less. Generator becomes self exciting since ac input power of 208 to 240 v, 60 cycles is obtained either directly from generator or through transformer on generator output. Tubeless magnetic-amplifier type unit is shockproof and has no controls in main regulator circuit—comes assembled on 19-in. panel or mounted in standard cabinet enclosure. Only maintenance is cleaning and checking on tightness of electrical connections.—Fidelity Instrument Corporation

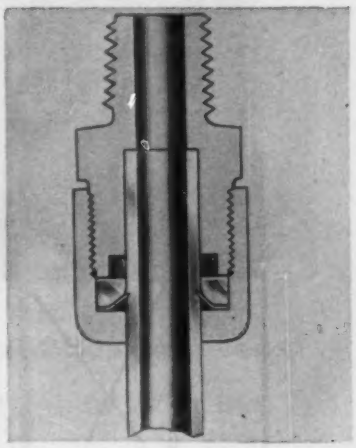
# information center for new products and materials

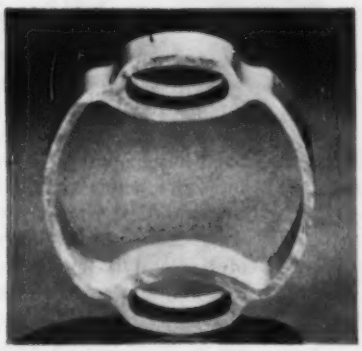
## Nylon fitting speeds copper-plastic-tube connecting

**5** • Fitting will connect copper, plastic or aluminum tubing in an effortless two seconds, maker claims. You can make connections without clamps for plastic pipe and without having to flare, bell or solder metal tubing. Butyl O-ring seal partially embedded in fitting is said to give a positive seal.

Simply insert fitting in tube with twisting motion. According to the manufacturer, you get a positive connection that's leakproof for gases and fluids over wide range of pressures and temperatures. Serrated spring-steel ring in front of O-ring seal bites into outer-tube surface. This gives fitting exceptional strength when tube and fitting are placed in tension. According to the manufacturer, this is the first connector which can be applied with speed and economy on small diameter plastic tubing.

Fitting is made of nontoxic nylon, Cycolac or Polypropalene resins. Installed fitting can be turned a full 360 deg without lessening seal's effectiveness or reducing fitting's grip on tube. This feature adds ease and speed to any job of installing tubing. Unit is available for ½- to 2-in. standard tubing with either male or female threads—comes assembled, ready for use with no makeup required. It can be disassembled for re-use.—D & G Plastics Company





## Built-in-channel tube eliminates extra piping

**6** • Tube with built-in channels should simplify and cut cost of recirculating heating fluids required in piping systems. The 1-piece extruded section has two integral channels flanking large pipe area. Heating medium travels through one small passageway, maintaining temperature of material in large area to insure free flow. If necessary, fluid is reheated at terminal and then returns through second channel. Tube comes in 2-, 3-, and 4-in. sizes.—Aluminum Company of America

## Versatile valve is maintenance-free

**7** • Valve combines three design elements—union bonnet, reinforced body and cylindrical body neck section. According to maker, valve's characteristics and built-in safety features make it suitable for all applications in the 125- to 150-psi steam-pressure range.

Long pipe threads in valve body permit tight valve-to-pipe jointing without risk of crowding pipe or distorting valve disks. Unit has deep stuffing box, hexagon head gland and back seats located above stem threads for most efficient performance—available with rising or nonrising stems, single- and double-wedge disks.—Lunkenheimer Co

## Hose withstands most chemicals

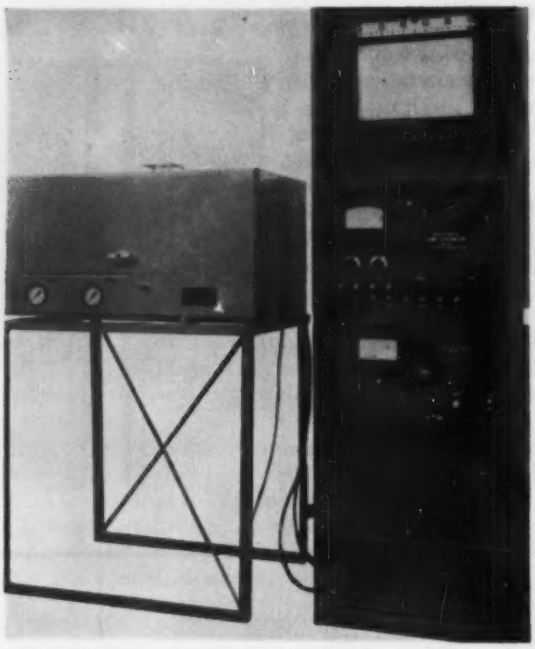
**8** • Teflon-lined hose has low permeability, zero weather absorption. According to maker, it will withstand all known chemicals except fluorine gas, chlorine trifluoride and molten-alkali metals. It's said to be both flexible and easy to handle, will end separation and splitting.

Cleaning and sterilization are easy since nothing sticks to waxy tube. Hose is especially suitable for flexible constructions in process equipment handling corrosives, caking slurries or solvents. You can use it at temperatures to 325 F and working pressures to 1500 psi.—Raybestos-Manhattan, Inc, Manhattan Rubber Div

For more data on these developments, circle key numbers on Reader Service card, p 103

# More **equipment news**

For more data on these developments, circle key numbers on Reader Service card, p 103



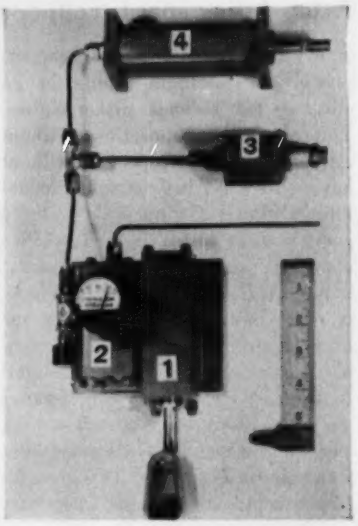
## Flame photometer senses parts per billion

**9** • Unit is calibrated for 0.1 to 10 ppb of sodium in boiler feedwater. By measuring sodium normally associated with chloride in feedwater, unit measures chloride ion content. According to maker it will also measure other materials exhibiting flame emission.

Photometer consists of optical unit, above left, and control panel on right. Optical assembly houses sample manifold, burner, monochromator and photomultiplier. H-v supply, amplifier, automatic standardizing system, sample-sequence selector and recorder are in panel. Flame emits characteristic radiation of impurity in sample. Potentiometer rectifies and measures signal voltage and thus records sample's impurity.—Waters Associates

## Span-adjustable zero recorder covers one to 250 mv

**10** • Null-balancing type recorder is designed for long life and trouble-free service, says maker. Unit uses line-driven synchronous converter and amplifier to control 2-phase motor rebalancing measuring circuit. Mv input converts into visual indication and permanent chart record. Zero adjustment is marked in arbitrary units from zero to 1000 and you can shift any selected span over maximum of ±50 mv. Chart speeds can be changed quickly, adapting unit to wide variety of processes.—Daystrom, Incorporated, Weston Instruments Div




## Pneumatic safety control senses pressures to 2000 psi

**11** • Safety-control system suitable for unattended machinery operates through small captive charge of compressed air. Basic elements are (1) hand-charging unit (2) pressure-sensing valve with charge air gage (3) temperature-sensing valve (4) actuating unit. Sensitive to wide range of temperatures and pressures, system will also work almost any type of pilot-operated valve, switch, warning or other control without outside power.—California Controls Co

## Bellows meter has 6-in. indicating dial

**12** • Meter is for flow and liquid-level applications that don't require recording or transmission. Equipped with stainless-steel pointer pinion, mercuryless meter measures 15 differential ranges of water from 0 to 20, 0 to 400 in. Unit should provide proper meshing and correct indication under all temperature and moisture conditions, says maker, and nylon-faced gear sector should assure long life in measuring pulsating flow.—Minneapolis-Honeywell Regulator Company, Brown Instruments Div

**• • • "Frictionless" design gives Flexotrol* longest life, stability and accuracy of any displacement level controller**

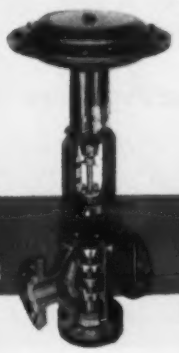
By avoiding knife edges, bearings and associated pressure-tight mechanical fittings, K & M has achieved almost frictionless operation in the *Flexotrol* Displacement-Type Liquid Level Controller. As a result, errors due to friction, distortion and hysteresis are practically nil.

Actuation is accomplished through a torque element which directly transfers displacer movement to the controller. There are no intermediate levers. Because the rotation of the tube is limited (4°) and because the whole assembly is constructed of high-durability materials, the torque system has remarkable fatigue resistance. Tests in excess of five million operating cycles have produced no detrimental fatigue effect.

The controller unit utilizes conventional 3-15 psi signal air pressure, has a 0-150% adjustable proportional band, may be direct-, reverse- or snap-acting without parts change. The *Flexotrol* Level Controller can also be converted to a transmitter-controller combination. Automatic reset and rate response are optionally available.

**Full details are given in Bulletin 456-1. A copy is yours for the asking.**

*Flexotrol is a trade-name of Kieley & Mueller, Inc.



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*Oldest Pressure and Level Control Valve Manufacturer*

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Aerotec Industries offers more than a half century of world wide experience in engineering and manufacturing equipment for efficient and economical cleaning and handling of air and gas. Single responsibility for complete systems, from design to final installation, assures management that overall performance guarantees will be met. Write for information on the products of interest.

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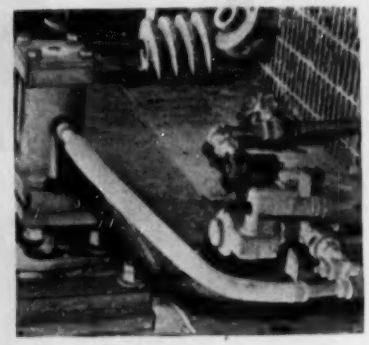
AEROTHERM • Aircraft lounges, passenger and crew seating.

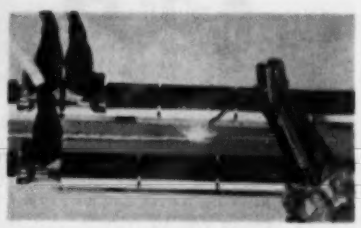
## Equipment news

Begins on page 128



### One-piece rapper

**34** • One-piece design of electrostatic-precipitator and dust-collector rapper is said to reduce maintenance headaches. Unit is made without assembly bolts to stretch, shear or leak air. Exhaust parts on both sides of housing keep vibrator piston centered, cutting housing wear.—National Air Vibrator Co



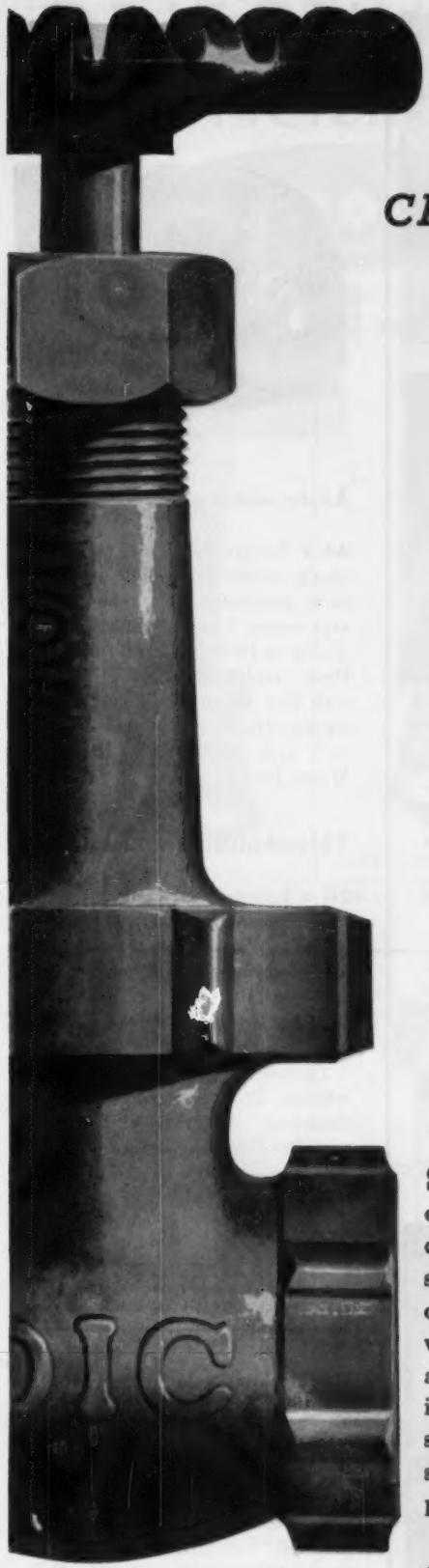
### Building-block preheat

**39** • Electrical strip-heater system preheats low-alloy high-tensile steels to prevent underbead cracking. This system should improve weld quality through close, continuous control of heat input to base metal and elimination of cold spots. You get complete protection of personnel and equipment against accidental contact, overloading, mechanical abuse and water damage, maker claims.

Reusable interchangeable 1- and 2-ft plug-in units can be added or removed as job requirements change. A system installs in about three hr. —J B Nottingham & Co

continued

Just circle key numbers on the Reader Service card, page 103, to get complete product story




## *CHECK OIC FIRST...IT PAYS!*

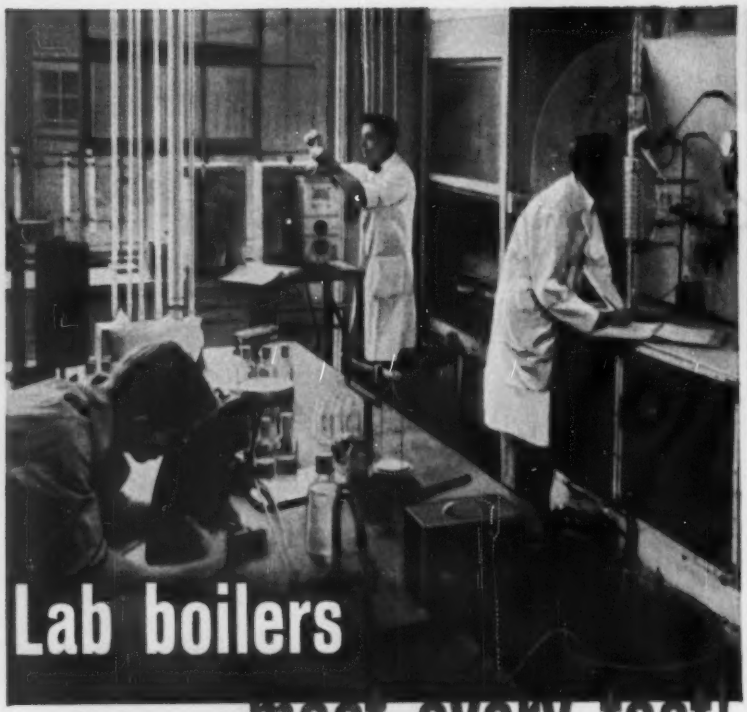
**SERVICE** to meet your valve needs is the "specialty of the house" at your nearby OIC Valve Distributor. As a first-line distributor, he gets OIC's all-out support to insure that you get the service you deserve. OIC's strategically located warehouses, and complete-line factory inventory "backstop" every OIC distributor with a multi-million dollar stock of bronze, iron, ductile iron, cast and forged steel valves. As a result of this strong distributor support, immediate delivery of the more popular items out of distributor's stock is common, and 4 to 5-day delivery out of warehouse or factory stock is routine. When quality is a problem, or delivery is urgent, phone your OIC distributor. Service is his business, and ours.

OIC VALVES | FORGED AND CAST STEEL, BRONZE, IRON AND DUCTILE IRON VALVES

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO



For more facts circle 263 on Reader Service card, p 103



# Lab boilers meet every test!

**Two Cleaver-Brooks 150-hp boilers satisfy all demands for steam at Shell Chemical Corporation's Union, New Jersey Technical Service Laboratories**

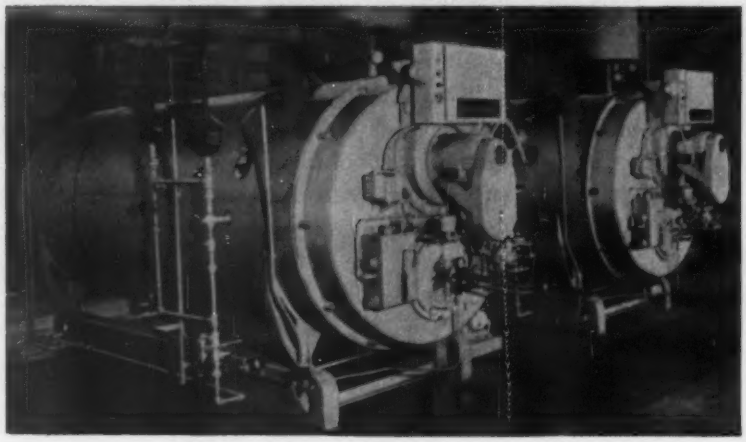
"We find Cleaver-Brooks boilers meet every test we have given them for top operating performance," reports George Baranchulk, utilities and service engineer at Shell's research building. Mr. Baranchulk goes on to say, "There is extreme versatility to our load as our requirements for heating and experimentation may run as low as 10 hp in the summer to over 140 hp in the winter. Checks we have made of $CO_2$ and stack temperatures indicate we are getting excellent operating efficiency — even when we vary the load over widely separated peak and low demands. These boilers have definitely lived up to every claim you have made for them."

Put Cleaver-Brooks packaged boilers to the test! They are available in sizes from 15 to 600 hp . . . for oil, for gas or for oil/gas combination firing. Contact your representative or write Cleaver-Brooks Company, Dept. G, 301 E. Keefe Ave., Milwaukee 12, Wisconsin.

Cleaver Brooks

ORIGINATORS AND LARGEST PRODUCER OF PACKAGED BOILERS

TESTING — Fully modulated Cleaver-Brooks boilers burning No. 6 oil supply steam for heating presses, constant temperature rooms, laboratory uses, laminating plastics and air conditioning system. Sold and serviced by Miller & Chitty Company, Union, N.J.




## Equipment news

Begins on page 128

### Ac-dc motors

**43** • Integral-hp ac-dc motors are ideally suited for mobile-field-equipment applications in remote areas, says maker. Line has ratings through 7½ hp in 1800- and 1200-rpm speeds. Open ventilated motors packaged with four silicon rectifiers in bridge circuit eliminate reconnecting for each type of current.—Robbins & Myers, Inc

### Thread-milling attachment

**28** • Low-cost attachment lets any lathe thread-mill internally and externally. Plastics are threaded without distortion; beryllium, stainless steel and titanium can be handled. Unit holds pitch and root diameters to close tolerance of .001 in.

Cutters range from ½ to 9 in. for internal, 1/32 to 9 in. for external threading. An unskilled person can complete threading setup in five minutes, maker states.—Fen-Thread Machine Co, Inc

Just circle key numbers on the Reader Service card, page 103, to get complete product story

### Nonstretch belting

**21** • All-synthetic transmission belting has a "molecular memory" making it nearly stretch-free, manufacturer states. Nylon bands, especially oriented for extra strength, and woven nylon cloth are used. Pulley side is coated with urethane for high coefficient of friction. Belts resist

# OBJECTIVE PERFORMANCE

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## AURORA® *Heavy Duty*

# NON-CLOG PUMPS

TYPE KUC VERTICAL—For compact installation with flexible coupling drive... motor high above floor.

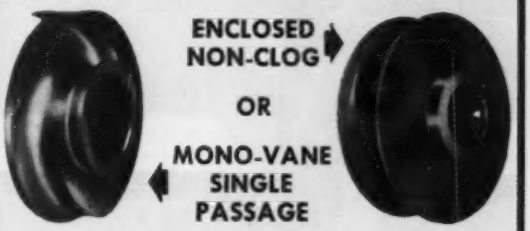
TYPE KCM VERTICAL—Utmost compactness... close-coupled design... low suction.

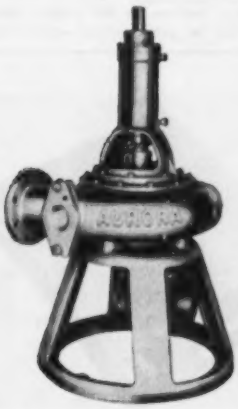
For handling heavy liquids... and solids in suspension. Ideal for public utility and industrial wastes.

Capacities to 9000 GPM • Heads to 150 feet • Solids size to 6 inches

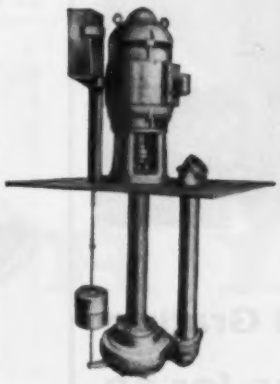
- Easy Installation
- Easy Disassembly
- Smooth—Quiet operation
- Hand cleanout provided in casings
- Detachable suction and packing covers
- Large Passageways
- Many optional features available
- Uniquely balanced impellers
- Engine or combination drives available
- Deep packing boxes

**ALTERNATE IMPELLER DESIGN**

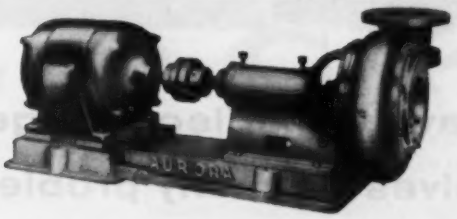


TYPE KU VERTICAL—For flexible shaft drive... misalignment proof ...elevated motor protection against pit flooding.



TYPE KS VERTICAL SUMP—For heavy duty wet pit service. Complete unit engineered to specific pit requirements.



TYPE KGG HORIZONTAL—Rugged base mounted unit ...for use where suction conditions permit horizontal mounting.

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MONO-VANE BULLETIN 121MV

NON-CLOG BULLETIN 121A

SUMP BULLETIN 104

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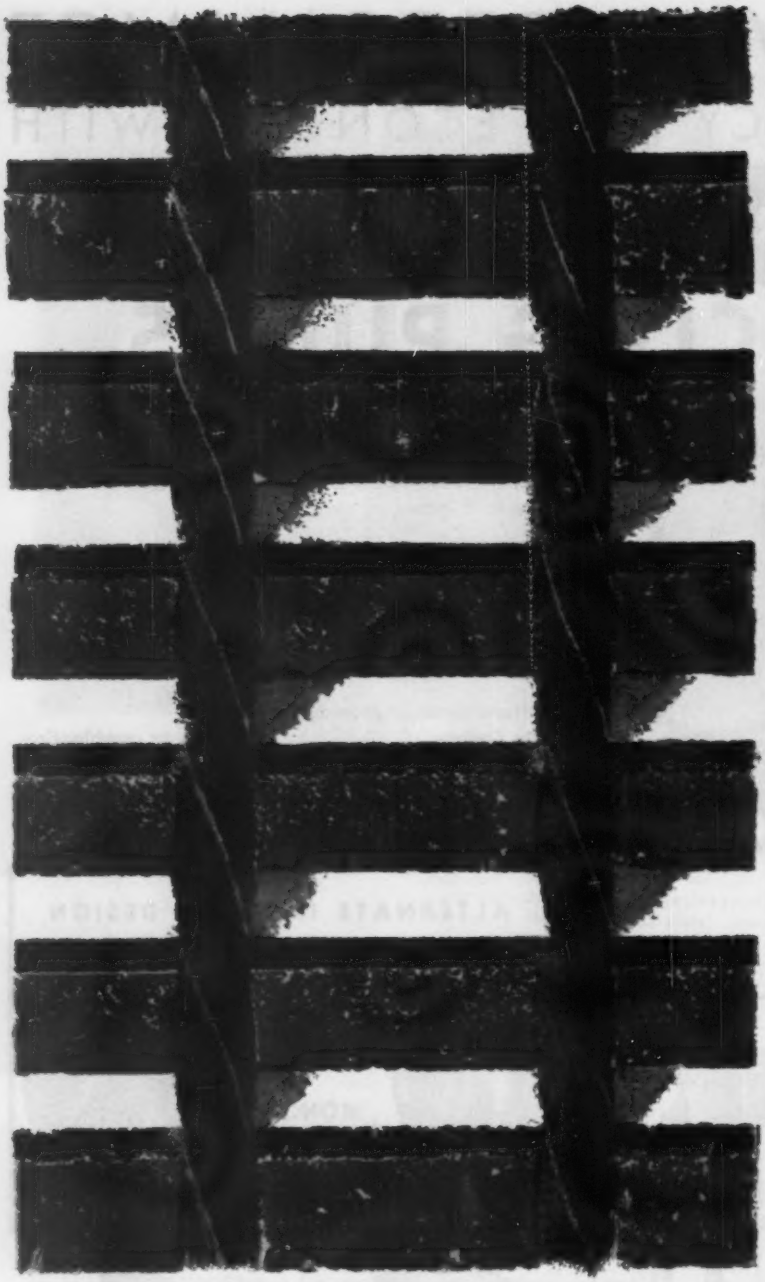
For more facts circle 265 on Reader Service card, p 103



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Blaw-Knox Equipment Division, Pittsburgh 38, Pennsylvania.

**BLAW-KNOX**
*GRATING*

## Equipment news

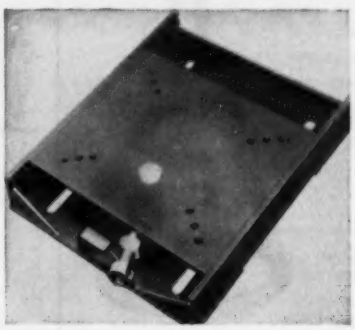
Begins on page 128

humidity, oils, many acids; they're said to withstand temperatures to 200 F.—L H Shingle Company

### Flue-gas damper

**31** • Shutoff damper for flue-gas ducts fits tightly. Operation is simple; only parts are housing, valve disk and operating device. No dust from gases can accumulate to obstruct the damper, says maker. Unit comes in sizes to handle gas or air from 6000 to 250,000 cfm.—American SF Products, Inc

Just circle key numbers on the Reader Service card, page 103, to get complete product story

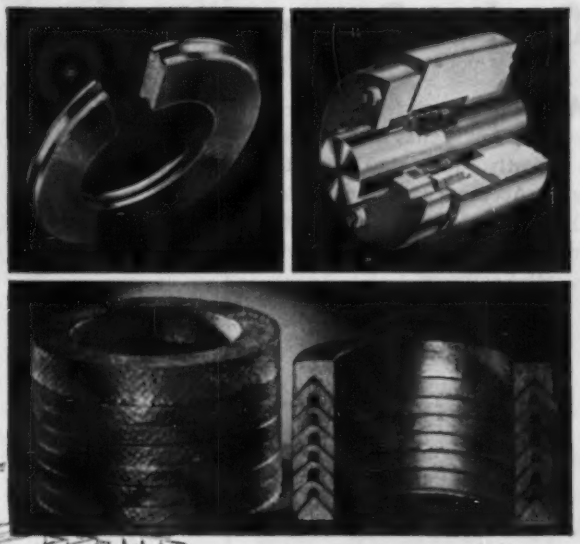


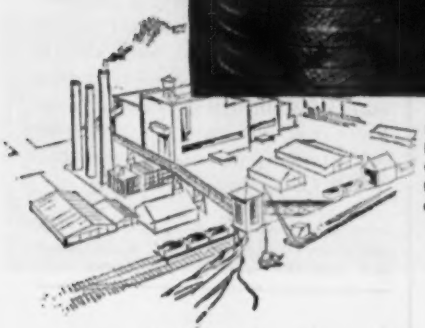
### Pancake motor base

**80** • Sliding motor base of low pancake type is for variable-speed-sheave installations. Unit provides rapid release of adjusting screw. Height is only 1 21/32 in. Amount of movement is 4½ or 6 in. depending on motor frame.—T B Wood's Sons Co

continued

## ENGINEERED PRODUCTS for Plant Maintenance





Garlock GUARDIAN Gaskets (upper left), PK Mechanical Seals (upper right), and CHEVRON Packings (bottom) are all designed to prevent leakage and lower maintenance costs on your plant equipment.

**Many utilities and industrial companies standardize on Garlock products for low-maintenance, leak-free sealing throughout the plant.**

**On flanged joints, valve bonnets, boiler tube caps, manholes and handholes,** Garlock GUARDIAN * Gaskets are expertly engineered to meet specific conditions of joint stress, corrosion, thermal and physical shock. This is accomplished by alternating spiral wound strips of required V-shaped metal and plies of proper filler material. *Gasket density* controlled by the proper relationship of filler and preformed metal assures a safe, resilient seal which adjusts itself to changes in operation conditions. Used at temperatures to 1050°F., pressures to 2500 psi, against steam, oils, gases, liquids—practically any size or shape *Large regional warehouse stocks* are maintained for your convenience and faster delivery, at *Camden, Cleveland, Houston and San Francisco.* Catalog AD-104.

**For rotating shafts,** Garlock PK Mechanical Seals are easy to install and maintain. They are completely self-contained . . . no parts to put together. Rotating portion simply slides onto shaft; stationary portion positions quickly. No parts of the seal move on the shaft or sleeve, eliminating wear on the shaft. Available in shaft sizes from $\frac{3}{8}$" to 3" for speeds up to 2000 f.p.m. and higher, 212°F temperatures, 150 psi pressures. Catalog AD-150.

**For rams, plungers, and reciprocating rods,** Garlock CHEVRON* Packings assure positive, low friction sealing. With an exclusive hinge-like construction, CHEVRON packing rings tighten to prevent leakage as pressures increase. When pressures decline, the rings ease off to permit free operation of the rod, ram, or piston without leakage. Also CHEVRON packing rings are designed to work efficiently in shallower stuffing boxes. Use against water, steam, oil, gases and chemicals to 600°F. Catalog AD-115.

# GARLOCK

**For more information,** call your local Garlock representative at the nearest of Garlock's 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for the catalog indicated. Garlock Inc., Palmyra, New York.

**Canadian Div.:** Garlock of Canada Ltd.

**Plastics Div.:** United States Gasket Company

**Order from the Garlock 2,000** . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

*Registered Trademark

with the ALLPAX Gasket Cutter

Maintenance men from Maine to Mexico have found that they can save hours of costly "down time" with this handy kit. Accurate gaskets can be cut quickly and easily by following a few simple directions—as easily as drawing circles with a compass.

The Allpax Gasket Cutter uses the "ironing principle" to hold material flat during the sweep of the cut, and prevents buckling and tearing common with make-shift devices. All materials in general use as gaskets may be cut to diameters ranging from ¼" to 36" using the popular No. 3 kit. Other kits available for maximum diameters of 12, 24, 48 and 60 inches. Allpax Gasket Cutters and accessory tools are neatly packaged in the permanent metal tool case shown above. An 18" square cutting board is supplied with each kit.

See your local dealer for additional information on the Allpax gasket cutter and our complete line of gasket materials.

ALLPAX

*"The Packing that Packs All"*

SEND FOR OUR CATALOG — TODAY!

A complete line of packing, tools, gasket materials
Distributors in principal cities

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 18, Quebec


## Equipment news

Begins on page 128

### Pipe filter

**46** • Simple clamp closure permits removal of body tube for cleaning element—pipe lines stay uncontaminated. Porous metal element can be used with or without filter aid. It comes as cylinder, bayonet, star or corrugated sintered woven-wire mesh. Filter will withstand up to 10,000 psi. Several pipe sizes are available. —Pall Corp, Micro Metallic Div

Just circle key numbers on the Reader Service card, page 103, to get complete product story

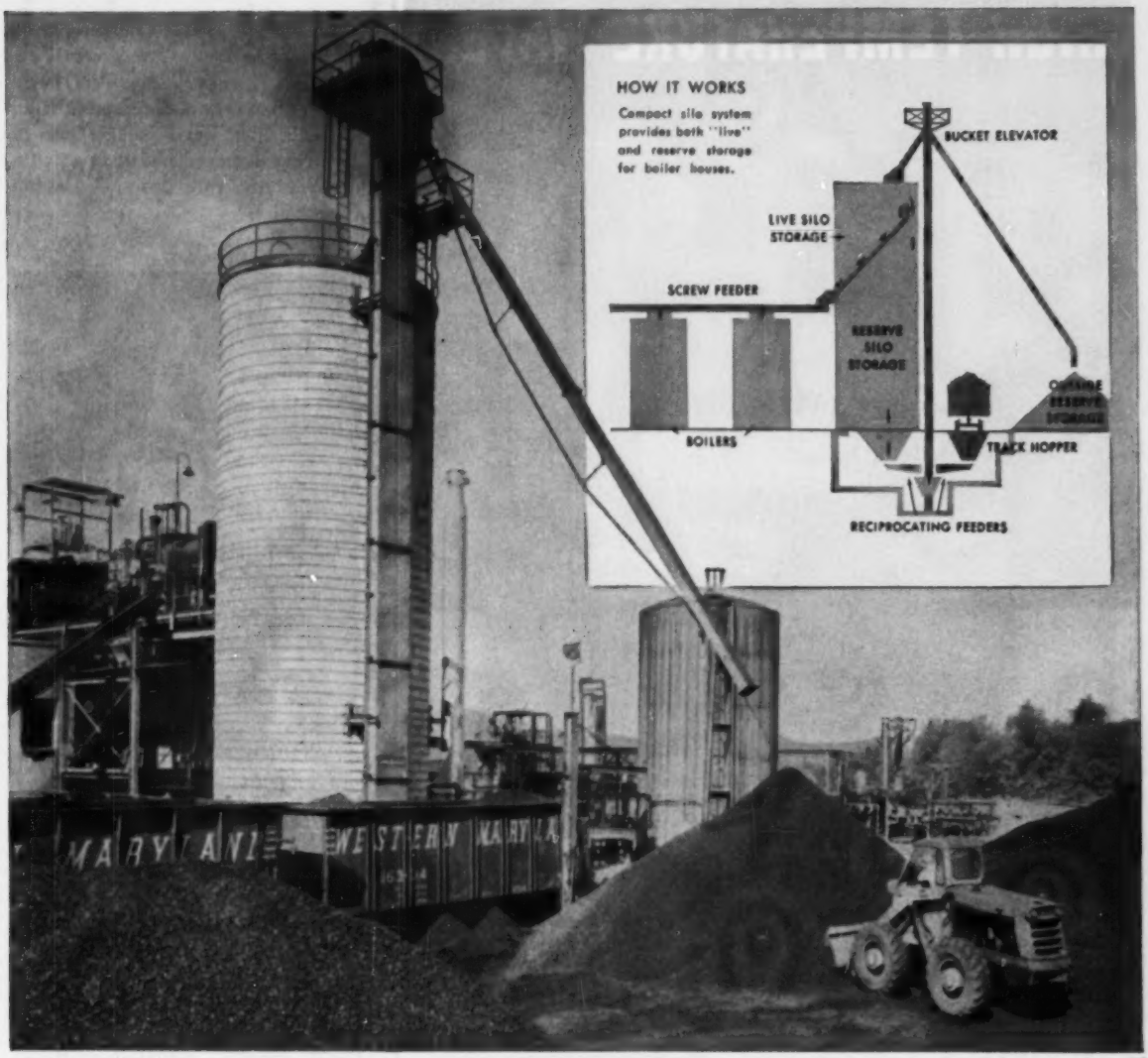
### Liquid soot remover

**20** • Liquid soot remover can be sprayed into hard-to-reach boiler areas. It adheres to soot on vertical and horizontal surfaces, lowering carbon's combustion point. When ignited with a paper torch, carbon burns away rapidly but not violently —and so thoroughly that you may not have to vacuum, according to the maker.—Parke-Hill Chemical Corp

### Epoxy tooling compound

**29** • Tooling and repair compound comes in two types, puttylike (No. 100) and liquid (No. 101). Both

# No boiler house too small to mechanize




**Link-Belt coal-handling mechanization** can effect new economies for the boiler house that consumes but a few tons of coal per hour. The same handling techniques that have brought significant savings and efficiencies to plants using thousands of tons per hour are applied with equal benefits to small installations.

Backed by virtually unlimited experience in this specialty, Link-Belt engineers can provide a coal-handling system exactly suited to your needs. Costs are kept to a minimum through the use of standardized components matched to capacity and layout requirements.

Next time you have a job that requires movement of materials or the mechanical transmission of power, call the Link-Belt office nearest you. If it involves coal-handling, ask for Power Plant Book 2410, or write LINK-BELT COMPANY, Dept. AV, Prudential Plaza, Chicago 1, Ill.

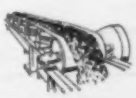
18.304

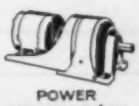
LINK-BELT

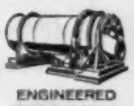
Basic products and engineering for industry's basic work

BEARINGS

CHAINS AND SPROCKETS

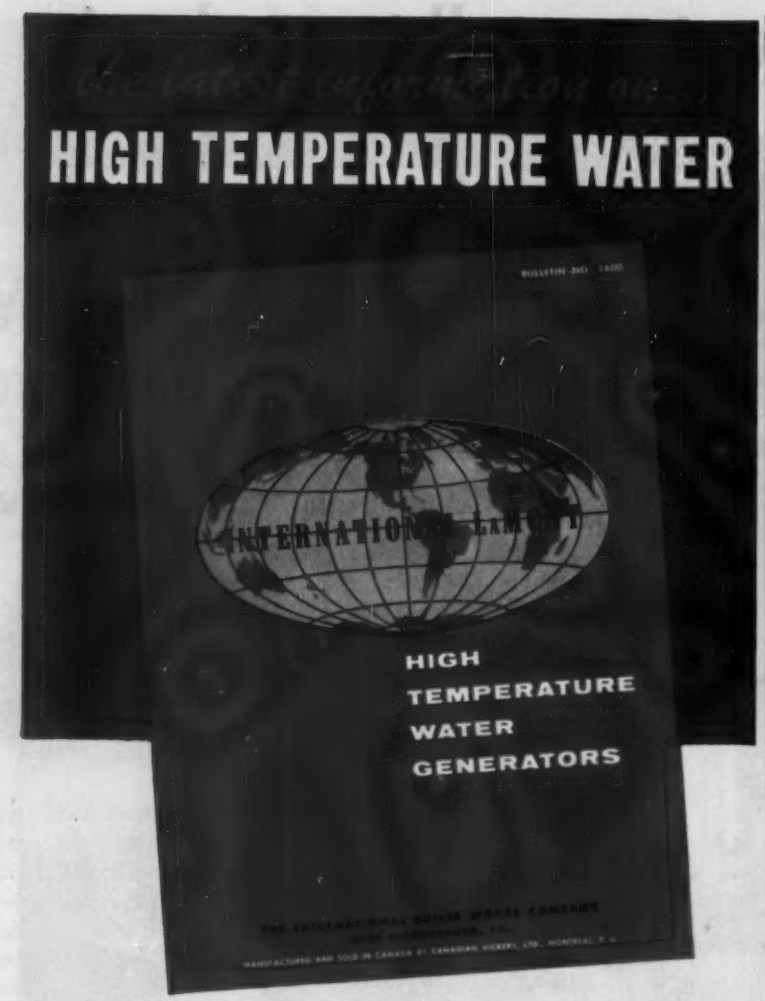

CONVEYING EQUIPMENT


POWER TRANSMISSION MACHINERY


ENGINEERED (PROCESSING) EQUIPMENT



For more facts circle 269 on Reader Service card, p 103

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## Equipment news

Begins on page 128

varieties are said to feature good tensile and compressive strength, resist most chemicals and oils. They'll bond to metals, wood, ceramics. High strength, light weight suggest use in repairing damaged machinery, foundry patterns, core boxes. — Devcon Corporation

### Insulation envelope

**44** • Wires, cables or pipes subjected to extreme hot spots can be protected with special insulation envelope of coated Dacron. Insulation zips on—one man can do the job. It will withstand temperatures to 300 F for 100 hr or more, 400 to 450 F for 10 minutes. Insulation envelopes come in all sizes in a variety of thicknesses.—The Zippertubing Company

Just circle key numbers on the Reader Service card, page 103, to get complete product story

### Pneumatic bunker cushion

**33** • Cushion exerts positive-displacement force of 56,000 lb to fight flow stoppages caused by funneling, bridging, caking in bins and hoppers. Rubber diaphragm bolted to reinforced-steel base measures about 31x39 in. when installed and reaches operating height of 15.75 in. Rubber shock cords connect membrane and

# "Splayed flange" insulation for large transformers

BROWN BOVERI

*By E. H. Stauffer, Project Engineer, Brown Boveri Corp.*

*Insulation materials of different dielectric strength have different angles of diffraction for the electric field. When layers of such dissimilar materials are used in an insulating barrier, stresses concentrate wherever angle changes occur. As a result, the dielectric strength of the insulation as a whole is much lower than for the sum of its components.*

## Cylinder and cap insulation

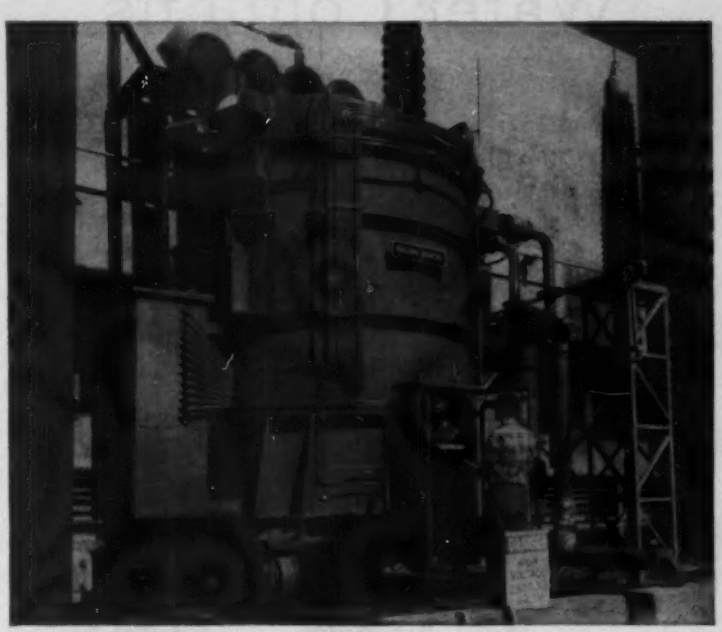
Conventional construction uses concentric bakelized or pressed paper cylinders and caps around the coils . . . with oil filling the spaces between cylinders. The electric strength of this barrier system is limited by the relatively low admissible tangential field forces along barrier surfaces and the dielectric strength of the insulation oil.

As a result, relatively large space is required between windings. This increases impedance as well as size and weight of the transformer.

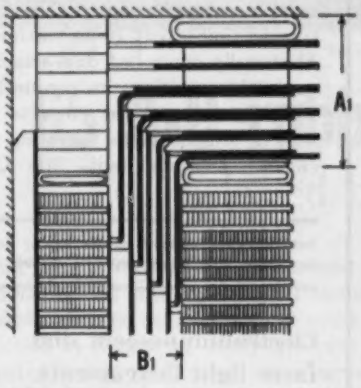
## Splayed flange insulation

In all large Brown Boveri transformers, insulation between coils is a continuous wrapper of oil-impregnated paper. This homogeneous barrier, like high-voltage paper cable insulation, has substantially higher dielectric strength than conventional barrier type insulation so that space between windings is reduced . . . with obvious advantages in cost and performance.

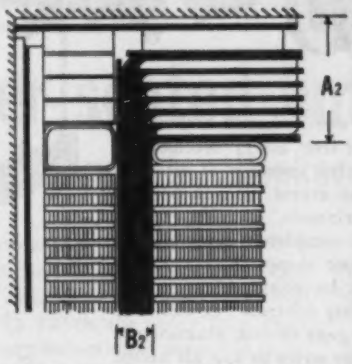
To prevent flash-over at the ends of the coils or between coil and yoke, each layer of paper is scored, bent over the top of the outer coil and splayed out to form a flange. This provides continuous insulation with no joints.



One of 13 Brown Boveri single-phase transformers with splayed flange insulation . . . at Robert Moses Dam, Massena, N.Y. All are 3-winding type equipped with forced oil-water heat exchangers and rated 86,000 kva. Six are 115-13.2/13.2 kv, six are 230-13.2/13.2 kv. The spare is reconnectable for either voltage.




Left: Section through transformer with cylinder and cap insulation. The spaces between cylinders and between cylinders and coils are filled with oil.




Right: Section showing Brown Boveri splayed flange insulation. Space is reduced between coils (B2) and between coils and yokes (A2).

## Reduced size and weight

The reduction in space between coils and between coils and yokes allows substantial savings in copper, iron, oil and insulation.

## Lower losses

The reduction in space between windings improves field leakage conditions and indirectly results in a smaller iron core, lower no-load losses and a smaller tank.

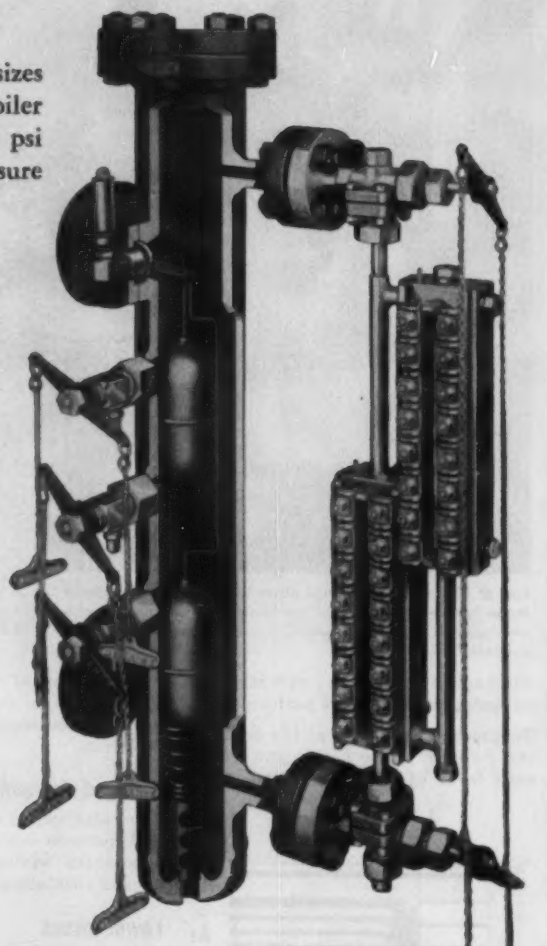
Hundreds of large Brown Boveri transformers totalling many million kw of capacity are in use . . . with no failures in the splayed flange insulation.

*NOTE: Brown Boveri's "radially laminated core" construction is also a factor in reducing transformer size and weight and in increasing efficiency. Details available on request.*

**BROWN BOVERI** Brown Boveri Corp., Dept. P6, 19 Rector Street, New York 6, N. Y. Agents in 27 U. S. cities.

# Insure safe, continuous boiler operation with **Reliance** Water Columns

Models and sizes for every boiler need to 2500 psi working pressure



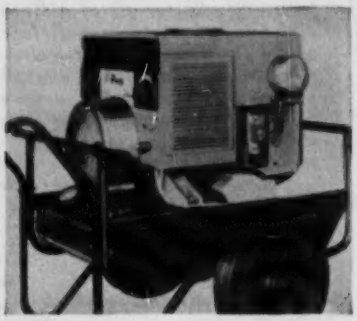
Reliance High and Low Alarm Water Columns are widely known for their sensitive trouble-free alarm mechanism. Action of the float and whistle valve assembly is direct — foolproof. Short, unhindered float travel assures prompt response to slight water level variations. Reliance Alarm Columns, available to 900 psi, are completely assembled at factory and thoroughly tested before shipping . . . Above 900 psi, forged steel columns can be equipped to supply electric alarm service and other safety controls . . . Reliance also makes gage cocks, gage valves, gage inserts, illuminators and vision-focusing hoods in various styles to suit all needs. Engineer representatives in all principal cities.

**The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio**

Reliance BOILER SAFETY DEVICES




exhaust valve for best mechanical control, prevent deflation before cushion reaches full height.—Tressler Engineering Products Div



## Dc welder—ac source

**35** • Portable dc welder produces extra ac power. As power source for lighting, motors, tools, unit provides 3500 w of 60-cycle single-phase ac. Generated dc welding output is 200 amp; unit takes ac and dc electrodes from 1/16- to 5/32-in. dia. Electric starting is an option.—A O Smith Corporation, Welding Products Div

## Vacuum coaxial relay

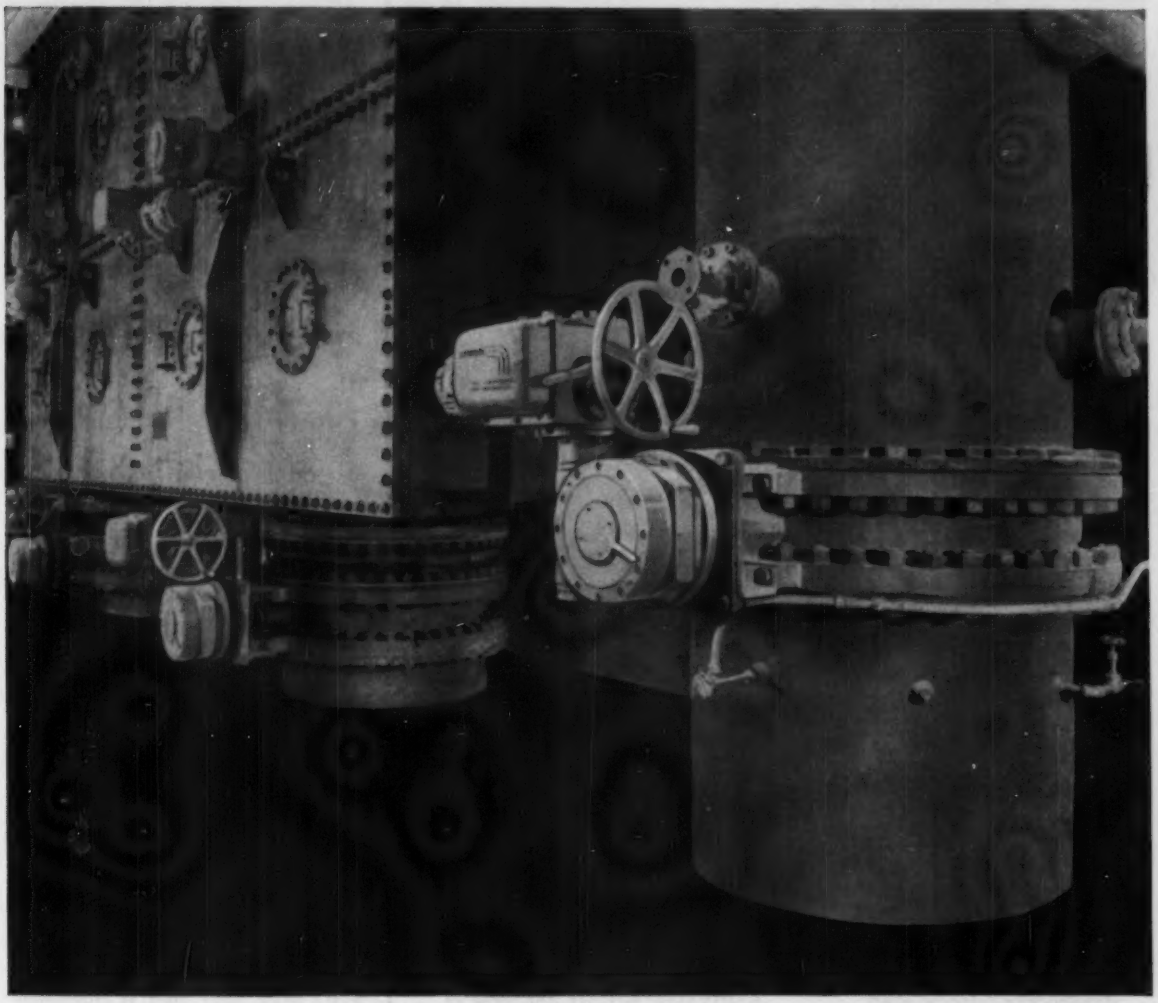
**27** • High-speed relay has power rating of 3-mw peak, 20-kw average to 600 megacycles. It is said to provide remote switching of 3⅛-in. coaxial lines rapidly and reliably. Total transfer time is only 10-ms maximum. Electrically controlled dual-actuating mechanisms acting in conjunction with vacuum-enclosed contacts are said to provide unit's operating efficiency.—Jennings Radio Mfg Corp

Just circle key numbers on the Reader Service card, page 103, to get complete product story

## Electroluminescent dial faces light instruments

**25** • Electroluminescent instrument dials featuring silhouette clarity and extra-long life are used for lighting panel instruments. Illuminated dial face is backed by a lamp base which is a vitreous-enameled steel sheet

# ALLIS-CHALMERS



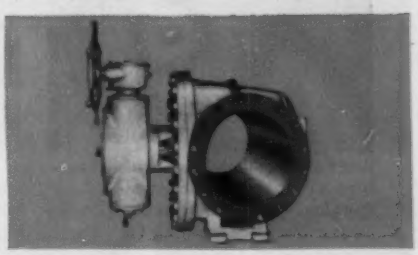
A-C rubber-seated butterfly valves now in service at Potomac Electric Power Company, Dickerson, Md.

# 65 A-C rubber-seated butterfly valves

## selected by Pepco for Dickerson Station

**Full body protection is a guaranteed advantage** with Allis-Chalmers rubber-seated butterfly valves. Potomac Electric Power Company depends on them, utilizing sizes from 6 to 72 inches in its new generating station at Dickerson. Forty-one butterfly valves are wafer type currently finding application where nonrotary valves once were the *rule.*

Allis-Chalmers rubber-seated butterfly valves are designed to reduce maintenance, eliminate tuberculation and oxidation . . . provide 100% effective shutoff. Operation is always *extra-smooth and easy. For details on our range of butterfly, ball and cone valves for power-plant applications, contact your A-C representative or write* **Allis-Chalmers,** *Hydraulic Division, York, Pa.*



**ROTOVALVE** units assure the most positive closing offered by any valve. Yet there's no more resistance to flow when full open than with a straight pipe of equal inside diameter. Closing time precisely controllable.

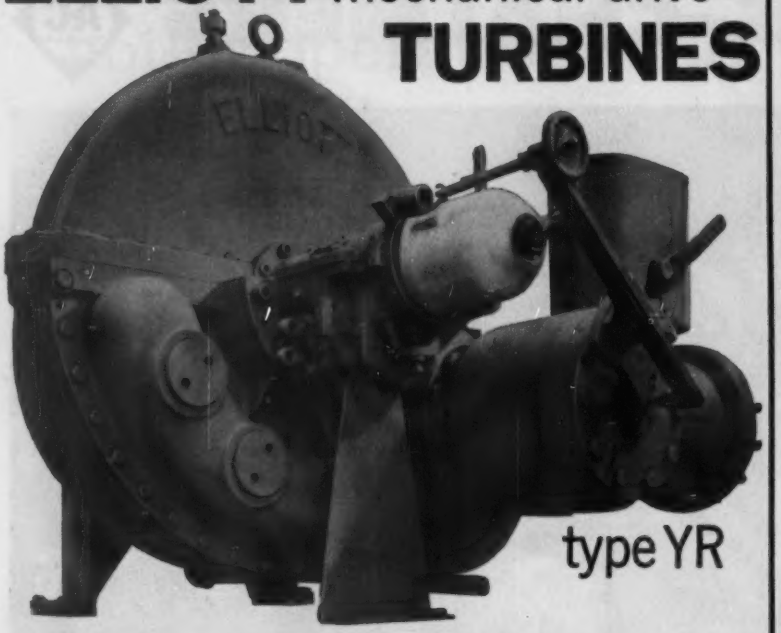
A-1330

*Rotovalve* is an Allis-Chalmers trademark.

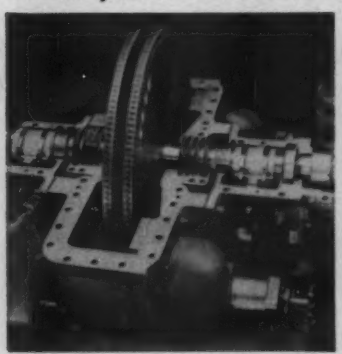


For more facts circle 273 on Reader Service card, p 103

# ELLIOTT mechanical drive TURBINES

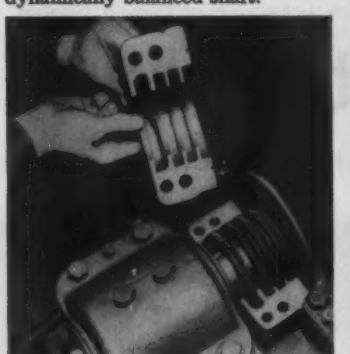



*These features mean long life, easy operation*



1. Smooth and dependable operation at all operating temperatures is assured by the precise alignment of the dynamically balanced shaft.

2. The governor is direct-acting, simple and weather-proof. Separate trip gives over-speed protection. Easily reset against line pressure.



3. Accessible shaft-seals and bearings simplify maintenance and inspection. Covers are readily removable without disturbing the casing.

4. Economy at partial loads is secured by the steam-saving hand valve with pilot, which can be opened against full steam pressure.

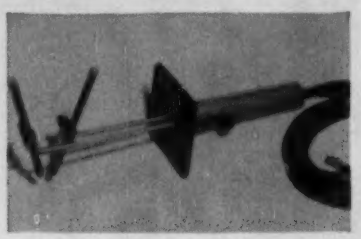
ELLIOTT Company
JEANNETTE, PENNA.

HO-2


## Equipment news

Begins on page 128

coated with electroluminescent phosphor. Operating principle requires no gases, filaments or emissive materials to be consumed.—Daystrom, Inc, Weston Instruments Div



### Twin-electrode welding torch

**61** • Torch is for any ac welding machine. To produce electric arc, it uses two cored carbon electrodes. Applications include heating, soldering, welding jobs. Unit operates on ac welding current; no gas is involved. —Arcair Co

### Combination starters

**22** • Switch type combination starters come in NEMA-12 dust-tight enclosures. New feature is a disconnect-switch mechanism with operating handle permanently attached to switch —no danger of false switch position indication when door is open. Handle is always in control of switch, and door can't be opened with switch on unless bypass is operated. Switch won't work until door is completely latched and sealed.

Interchangeable fuse clips accommodate 250- or 600-v fuses.—Square D Company

Just circle key numbers on the Reader Service card, page 103, to get complete product story

### H-v switch

**45** • H-v switch is especially designed for distributing power from rectifiers to electrodes of electrostatic precipitators. Multideck rotary switch will operate in all types of insulating oils, says maker. Housed in its own compartment it occupies 1 cu yd. Switch is engineered for 100,000 v,

# ALLIS-CHALMERS

A-1233

Allis-Chalmers 215,000 lb./hr. tray deaerator with 7200-gallon horizontal storage tank at a southern chemical plant.

# Corrosive gases removed

## from boiler feedwater with Allis-Chalmers deaerators

**Positive corrosive gas removal** by Allis-Chalmers tray-type deaerators is proved by a pilot unit (below) equipped with a continuous oxygen analyzer and recorder. It utilizes unique counterflow design for thoroughly scrubbing dissolved gases from the water surface. Design produces maximum heating of water with minimum of steam loss in venting. Effective deaeration is guaranteed under all loads.

**Ruggedly constructed,** A-C deaerators employ 16-gauge 18-8 stainless steel on all equipment exposed to corrosive gases. No moving parts assures quiet operation, minimum maintenance. Inspection is easy through ample access doors and manholes. Service? Seventy-seven district offices throughout the nation. Your A-C water conditioning engineer can give you full deaerator details. **Allis-Chalmers,** Power Equipment Division, Milwaukee 1, Wisconsin.

Pilot deaerator permits evaluation of tray designs.

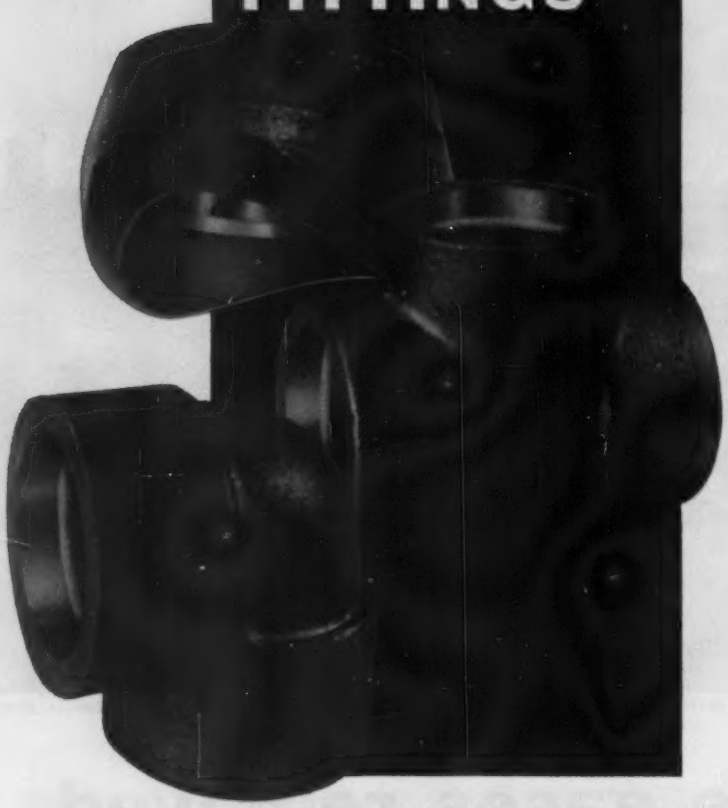
"Standard" deaerators for small industrial power plants.



For more facts circle 275 on Reader Service card, p 103

BONNEY

COPPER–NICKEL SOCKET-WELDING FITTINGS



BONNEY

WELDOLETS®
THREDOLETS®
SOCKOLETS®
ELBOLETS®
BRAZOLETS®
SWEEPOLETS®

CARBON STEEL
STAINLESS
ALLOY
for all services

Forged copper-nickel Sockolets, tees and ells are now available in both 70-30 and 90-10 for welding and silver brazing.

Bonney was one of the first companies to successfully drop forge copper-nickel. For the past few years Sockolets have been used more and more extensively on both Navy and commercial ship piping on salt water lines.

And now Bonney forges socket tees and socket elbows for use on the same systems and has been one of the principal suppliers of copper-nickel fittings on the nuclear submarine program.

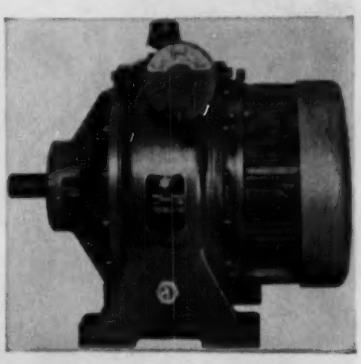
For fast service and assurance of superlative quality, rely on Bonney Forge for your copper-nickel fitting requirements.

BONNEY FORGE and TOOL WORKS
ALLENTOWN, PENNSYLVANIA

## Equipment news

Begins on page 128

one amp, has double-blade action. Structural members are of epoxy resins.—Buell Engineering Co, Inc

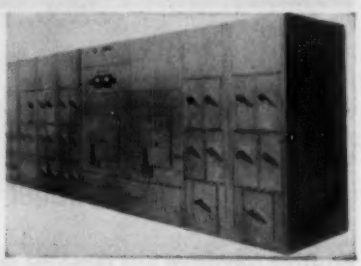


### Variable-speed drive

**40** • Variable-speed drives feature built-on motors—unit shown above includes 5-hp pancake motor. Drive is compact, often can be adapted to existing machinery.

All-metal traction drive gives stepless control. It's offered in capacities from fractional to 16 hp.—Eaton Manufacturing Company, Cleveland Worm & Gear Div

Just circle key numbers on the Reader Service card, page 103, to get complete product story



### Modular switchboard

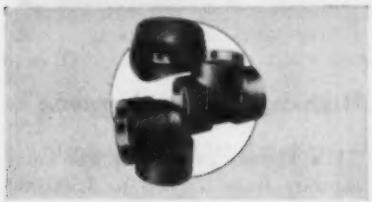
**42** • Distribution switchboard meets operating requirements through 5000 amp. Switchboards are designed for use where service needs range from 600 through 5000 amp, 250 and 600 v. Unit also gives fault protection on short circuits up to 200,000 amp.

Modular design lets you add, replace or interchange switches in matter of minutes. Front removal for

A Bonney forged cupro nickel sockolet fitting being fusion welded to a cupro nickel pipe.

# NEW FORGED CUPRO NICKEL FITTINGS SIMPLIFY INSTALLATION OF PIPING SYSTEMS

A considerable saving in the installation of cupro nickel piping systems can be effected by the use of forged cupro nickel welding fittings like those shown on this page. They make it possible to install full lengths of pipe or tubing and cut in branches afterward without the use of complicated fittings and sizing techniques.

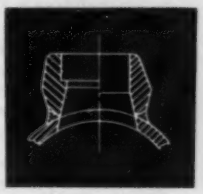


Bonney Forge and Tool Works, Allentown, Pa., drop forges socket welding outlets (sockolets), socket tees, and socket elbows from Anaconda Cupro Nickel, 10%-755 and Cupro Nickel, 30%-702 rod. They are widely used in salt water lines for both Naval and commercial applications.

The trend to higher water velocities in salt water lines—plus the growing economic importance of uninterrupted continuity of service—on shipboard and in tidewater power plants and oil refineries is leading to an increasing use of cupro nickel in piping.

The alloy coming rapidly into prominence is Cupro Nickel, 10%-755, developed by Anaconda for this kind of service. It has much of the corrosion resistance of Cupro Nickel, 30%-702, but costs considerably less. It is resistant to corrosion by both clean and polluted sea water, even at relatively high velocity of flow, and is resistant to corrosion by sea water containing air bubbles.

**TECHNICAL ASSISTANCE.** The Metallurgical Department of The American Brass Company is regularly working with manufacturers and users of heat transfer equipment and systems, helping to select the alloys best suited to the service. For technical help or information on alloys and tubes, write The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.



Bonney cupro nickel fittings for fusion welding to cupro nickel pipe are available for socket weld or silver braze of outlet (left, in drawing) or for butt weld of outlet (right), and for threading of outlet (not shown). Size range: outlet, ¼"-6" for run pipe sizes, 1"-24".

**ANACONDA®**

**COPPER AND**

**COPPER ALLOY MILL PRODUCTS**

*Made by The American Brass Company*



For more facts circle 277 on Reader Service card, p 103

## Here's why you're money ahead

*with A. O. Smith glass-protected smokestacks*

- Now available in a variety of colors
- They last longer — as much as 3 to 5 times longer than unlined steel stacks — corrosion resistant regardless of excess condensate
- Glass is tough, durable — shows remarkable resistance to impact or abrasion
- Maintenance is low! There's no painting—glass can't rust
- Economical to install — no need for special equipment or highly skilled workmen

Write Dept. P-60 for full facts.

Through research ... a better way

**A.O.Smith**

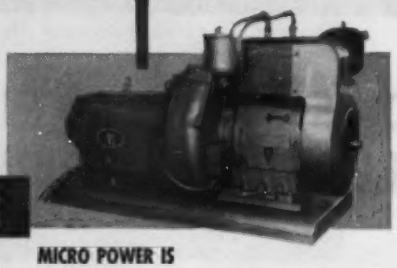
SMOKESTACK SALES
PROCESS EQUIPMENT DIVISION
P. O. Box 584
Milwaukee 1, Wisconsin

For more facts circle 278 on Reader Service card, p 103

## DOUGLAS AIRCRAFT
TULSA DIVISION . . .

*assures effectiveness of its protective boiler flame controls with . . .*

## MICRO POWER



In plants like Douglas Aircraft Company, Inc., in Tulsa, Oklahoma, where a continual supply of steam is vital to production processes, every precaution must be taken to assure against the hazards of boiler flame-out. To safely regulate its burners in the event of flame-out, the company utilizes highly sensitive electric controls. Since these flame failure controls *are* electric and must depend on a constant, unwavering power supply for successful operation, this is achieved with MICRO POWER.

At Douglas Aircraft in Tulsa, Micro Power serves as the dependable rear guard to the boiler room. It provides a constant source of steady, independent electrical power as required by the safety controls, thereby eliminating voltage fluctuations and protecting against power failure.

**MICRO POWER IS ALSO USED . . .**

- on microwave systems for communications, for remote control, for telemetering.
- for refinery and chemical process indication and control.
- by public utilities through microwave for protective relaying, telemetering and load distribution.

**MICRO POWER PROVIDES . . .**

- a constant uninterrupted source of electric power.
- voltage and frequency at usable value during transfers between motor and engine.
- stable voltage output.
- flywheel starting — no storage batteries.
- electrical isolation from commercial source — voltage dips, peaks and breaks do not affect microwave equipment, no transfer switch.

*For complete information on this and other Micro Power applications, write . . .*

US

**UNITED STATES MOTORS CORPORATION**

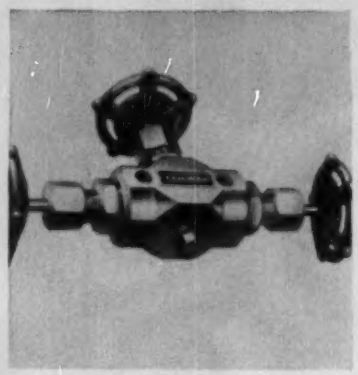
102 W. 8th Avenue — Oshkosh, Wisconsin

For more facts circle 279 on Reader Service card, p 103


## Equipment news

Begins on page 128

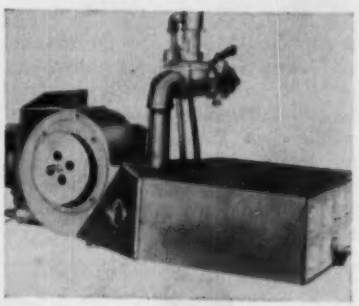
inspection will not disturb bus or adjacent units.—Federal Pacific Electric Company



### Instrument valve manifold

**48** • Manifold combines three valves in a single body; two provide line shut-off, the other equalizes pressure to protect instrument's internal working parts. Connection tap calibrates high pressure. Manifold should provide simpler and more dependable means of connecting flowmeters, level indicators, other instruments.—Yarnall-Waring Company

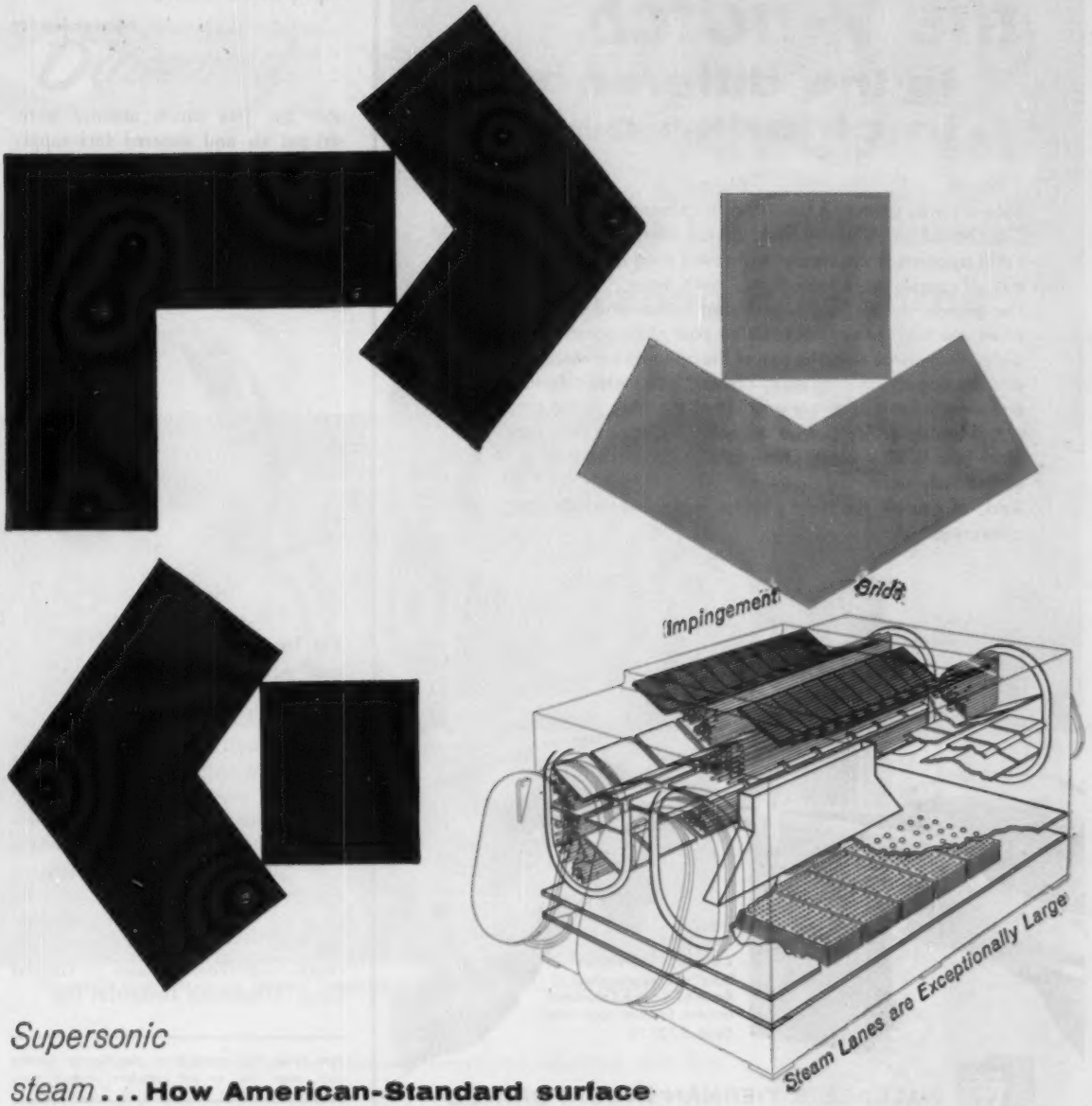
Just circle key numbers on the Reader Service card, page 103, to get complete product story



### High-capacity gas burner

**71** • Fan-air gas burner has input capacity from 100,000 to 3,500,000 Btu per hour. Burner features low cost, opportunity for furnace, boiler, process-equipment conversion.

Operating with air from low-speed fan, junior-sized burner has remov-




*Supersonic steam* . . . **How American-Standard surface condenser design guards against erosion**

Wet steam from the turbine may enter the condenser at supersonic speeds—up to 1200 feet per second. Entrained moisture particles strike like rifle bullets . . . can erode unprotected tubes to quick failure. Impingement grids, standard equipment in every American-Standard* Surface Condenser, deflect and slow down these moisture bullets. Wide steam lanes reduce steam velocity to 100 feet per second, or less. This is why our surface condensers serve for years without tube failure from impingement erosion. Be sure you have all the story. Write for Bulletin 8.2k1. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation

AMERICAN-Standard
INDUSTRIAL DIVISION
AMERICAN BLOWER PRODUCTS • ROSS PRODUCTS • KEWANEE PRODUCTS


For more facts circle 280 on Reader Service card, p 103

# the V-notch is the difference in chlorine control

Safe chlorine control is the job of a chlorinator.
This control, the V-notch, does the job completely.
Yet it appears to be simply a grooved plug in a ring.
It is, of course, more than that... much more.
The groove in the plug is precision milled and shaped so that when you turn the control knob on your chlorinator and the plug slides through the ring, the size of the opening between the groove and the ring changes an exact amount. You meter chlorine exactly and simply because every position of the plug in the ring makes a repeatable orifice size—a repeatable chlorine flow rate.
Only in a W&T V-notch Chlorinator is control so simple, so true, so precisely right.
And, of course, the right plastics make the whole chlorinator chlorine-proof.

A booklet, "The V-notch Story" will tell you about all the W&T V-notch Chlorinator features. For your copy write Dept. S-127.76

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET. BELLEVILLE 9. NEW JERSEY

IF IT'S **FREE FLOWING AND DRY** we have accurate reliable means of feeding it. For information about these dry chemical feeders *both gravimetric and volumetric...*

Write Dept. M-42.76

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET. BELLEVILLE 9, NEW JERSEY


## Equipment news

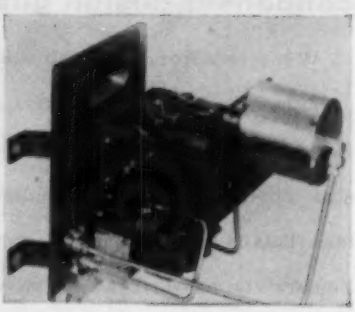
Begins on page 128

able gas jets which atomize unrestricted air and metered fuel supply in each of four burner ports. Instant combustion of gas-air mist close to burner permits clean burning, fuel savings.—The Mettler Co, Inc

### Turbocharger—small and efficient

**69** • Said to be smallest and one of most efficient in its field, Model T-11 has 8-in. housing dia. It's designed for diesel engines in 150- to 350-hp range. According to maker, it lets diesels work at lower peak pressures with better fuel economy. Housing and manifold design gives more efficient use of exhaust-energy gas, manufacturer claims. Fewer parts decrease maintenance costs. — Garrett Corp, AiResearch Industrial Div

Just circle key numbers on the Reader Service card, page 103, to get complete product story



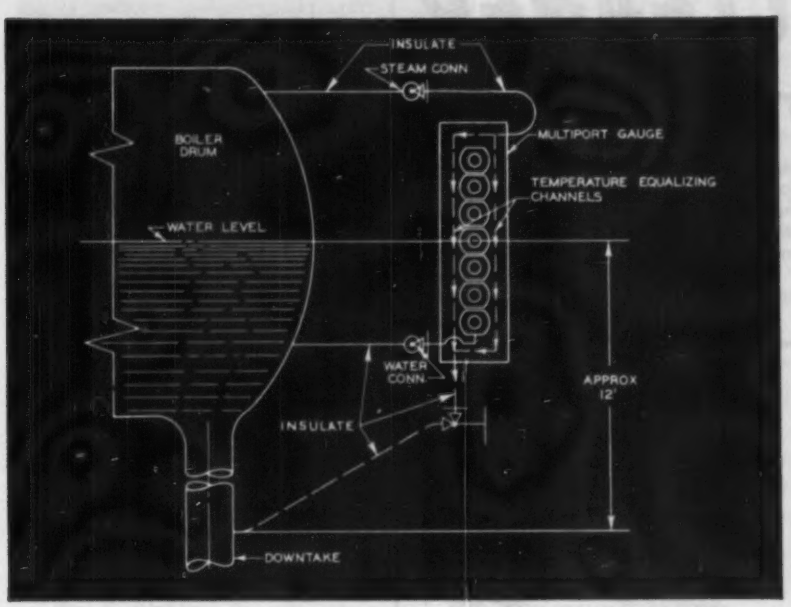
### Relays for extracting square root, squaring

**84** • Pneumatic wide-band relays for square-root extracting and squar-

Diamond

# Temperature Equalizing MULTI-PORT GAUGE*

## Improves Accuracy of Water Level Indication at High Operating Pressures



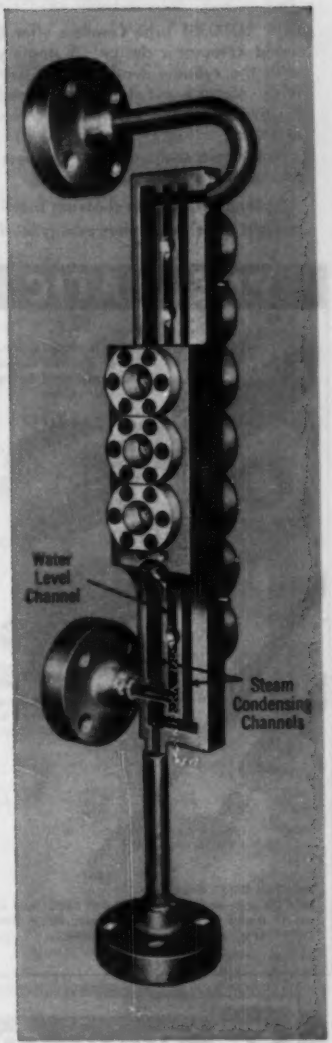

Diagramatic illustration of new Diamond Temperature-Equalizing Multi-Port Gauge installation.

By a simple reliable means the Diamond Temperature Equalizing Multi-Port Gauge* effectively reduces error in gauge level reading at high operating pressures.

Gauge error (resulting from the gauge temperature being lower than boiler saturation temperature) is substantially avoided by introducing supplementary gauge heating in the form of steam condensing channels. These channels are parallel to the gauge water level channel as illustrated, and serve to heat the gauge level channel by direct conduction of heat from condensing steam through the gauge body itself. No external source of energy or control is required. The heating channels have a natural circulation system independent of the gauge level channel so that no faulty operation can occur under any circumstance.

Ask your local Diamond office or write directly to Lancaster, Ohio for Form 2150 for further information.

*Patent Applied For.




Cut-away sections illustrate independent gauge body heating channels of the new Diamond Temperature-Equalizing Multi-Port Gauge.

**DIAMOND POWER SPECIALTY CORP.** 8274

**LANCASTER, OHIO**

DIAMOND SPECIALTY LIMITED—Windsor, Ontario



For more facts circle 282 on Reader Service card, p 103

# ROTOJET

## The modern TUBE CLEANER

## Fast • Powerful • Efficient

Only ROTOJET Tube Cleaners offer the simple, efficient, time-tested Rotocentric design. A single paddle maintains contact with the cylinder wall without depending upon centrifugal force. Motor won't stall at low speeds caused by heavy loads. Positive starting is assured with Rotojet motors driven by air or steam.

Rotojet water-driven Tube Cleaners are comparable in speed and power with air-driven types.

Send for bulletin showing motors, heads, and brushes for straight and curved tubes and pipes from ⅛" to 12" I.D.

*Section of ROTOJET pneumatic motor showing simple design.*

**PNEUMATIC**

Model C-525 ROTOJET Air-driven Motor with swing-frame head and universal coupling for 2¾" to 3½" I.D. curved tubes.

Model S-536 ROTOJET Air-driven Motor with swing-frame head for 2⅛ to 3-13/16" I.D. straight tubes.

Model C-536 ROTOJET Air-driven Motor with single pin head and universal coupling for 1¾" to 2½" I.D. curved tubes.

Model C-434 ROTOJET Junior Air-driven motor, flexible holder, expanding brush.

**HYDRAULIC**

Model C-322 ROTOJET Water-driven Motor with 3-arm head and universal coupling for 2¼" to 2½" I.D. curved tubes.

Model S-360 ROTOJET Water-driven Motor with combination drill head and universal coupling for 2¼" to 3⅛" I.D. straight tubes.

Model C-321 ROTOJET Water-driven Motor with short 4-arm head and universal coupling for 2½" to 3" I.D. curved tubes.

ELLIOTT COMPANY – ROTO PLANT

*Tube Cleaner Specialists Since 1910*

153 Sussex Avenue, Newark, N. J.


## Equipment news

Begins on page 128

ing for control systems employ null-balance - vector mechanism. Relays extract square root down to 10% of input span and 1% of output span. Units have input and output ranges of 3 to 15 psig with air consumption of 0.2 scfm and nominal error of 1% of output span. They have high-grain integral pneumatic amplifiers to simplify piping, reduce number of air sets per system and air consumption. —Republic Flow Meters Company

### Fuel-oil additive controls slag, corrosion

**86** • Fuel-oil additive 7D-24 eliminates fireside accumulations of soot and slag, maker claims. Metering systems for using additive directly in fuel stream are provided. Additive has been field tested.—Nutmeg Chemical Company

Just circle key numbers on the Reader Service card, page 103, to get complete product story

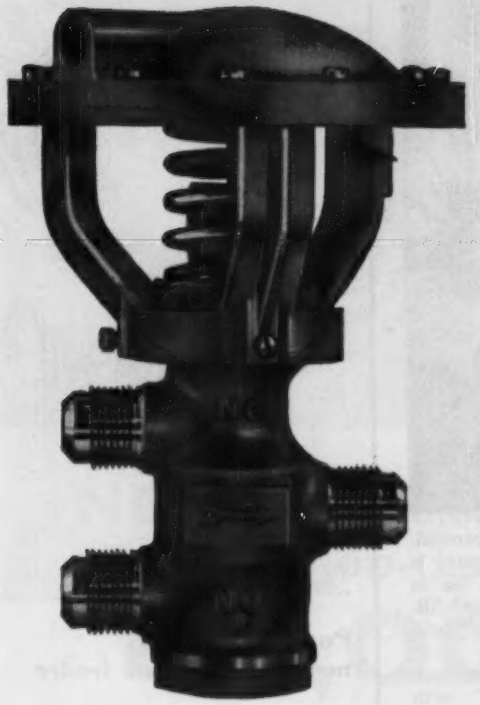
### Flame-resistant epoxy

**91** • *Epoxy 1202* comes in molded cylindrical and square shells, custom-molded components and liquid epoxy resin. It has extinguishing time of zero to one second, is applicable to computers.—Epoxy Products

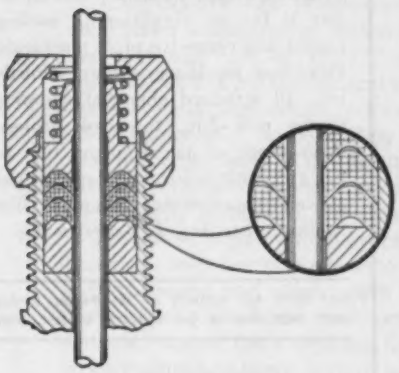
### Dc power supplies

**49** • Silicon - regulated dc power supplies feature low transients, low drift and no spikes. Ratings are from 100 to 1500 amp, 14 to 36 v. According to maker, short circuit across load

# JOHNSON WATER VALVES
## FOR SMALL ROOM AIR CONDITIONING UNITS



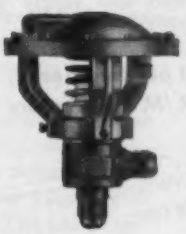
V-154 Three-Way Mixing Valve
(Inner Valve — Flat Disc)



Valve Packing Detail

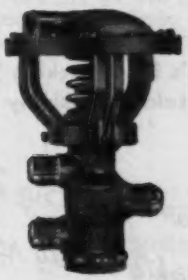
- Specially designed for accurate, trouble-free control of hot and chilled water in unit air conditioners. Compact, easily installed in confined spaces.
- Special V-ring, self-sealing packing:
  - a. Utilizes the force of the water pressure to effect a positive seal. Always has the right packing gland pressure to prevent leakage.
  - b. Requires no initial manual adjustment.
  - c. Automatically compensates for wear, eliminates need for servicing.
  - d. Minimizes friction because sealing force is proportional to fluid pressure.
  - e. Automatically compensates for changes in water temperature.
- Long-wearing, resilient molded rubber diaphragm. Diaphragm top can be removed without disturbing balance of assembly.
- Adjustable spring range permits synchronization of operation of valves in several units when controlled by a single thermostat. Special spring construction eliminates spring set and fatigue.
- ½" O.D. S.A.E. flare connections fit tubing employed with unit. No special pipe to tubing adapters required.

Full details are contained in Bulletin Nos. V-152, V-154, and V-164. Write Johnson Service Company, Milwaukee 1, Wisconsin.



V-152
ANGLE VALVE

V-152
OFFSET GLOBE VALVE



V-164
THREE-WAY MIXING VALVE
(Inner Valve-Modulating Plug)

**JOHNSON CONTROL**

PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

OUR 75TH YEAR



For more facts circle 284 on Reader Service card, p 103

*This maintenance engineer is*

# Seven*eering*" with R/M

*for packings that are chemically impervious*

To be sure that the packings on the acid pumps in his plant will provide a positive seal while resisting the materials handled, this maintenance engineer is installing R/M Big 7 Packing Type #5. His R/M packing distributor recommended R/M No. 848, a packing constructed of cross-locked, braided "Teflon"* filaments and impregnated with a special lubricant for dynamic service. R/M No. 848 has superior chemical resistance and is ideal for equipment handling solvents, dilute and concentrated acids, alkalis and slurries.

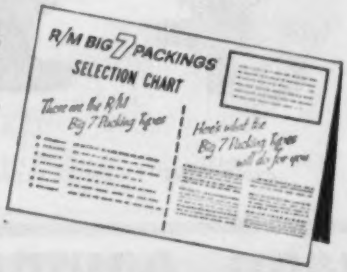
In packing valve stems, he will use R/M Nos. 840 SW and 840 SB. Both are made of high-grade asbestos yarn impregnated with "Teflon" suspensoid. R/M No. 840 SW white asbestos is particularly recommended for use in handling solvents. R/M No. 840 SB, blue asbestos, is best used in acid service.

Join the thousands of maintenance men who are "Seveneering" with R/M to reduce inventory and eliminate selection error. And remember, whatever your packing requirements, R/M's Big 7 Packings are engineered to do the job without compromise. Call your authorized R/M distributor today. He will help you solve your packing problems and supply your needs immediately.

*Registered TM for Du Pont fluorocarbon resins

**R/M's Big 7 Packing Types meet 95% of all packing needs, are sold exclusively through authorized R/M distributors**

*This new R/M Big 7 Chart is a mighty handy reference. Send for your copy now.* →



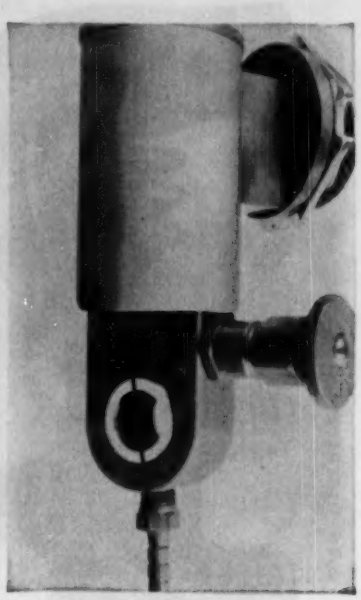

**BIG 7 PACKINGS**

RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS


## Equipment news

Begins on page 128

will not damage rectifiers and transistors. A 400% overload is withstood for one sec without harm to unit. Low drift of 0.05% for indefinite period is featured in all ratings. —Sprague Engineering Corp



### Pumpless, gravity-metering drop-rate feeder

**85** • Compact maintenance-free drop-rate feeder with head loss equalizer is for air conditioning cooling towers and corrosive plant chemicals. Head-loss equalizer screws directly into all standard chemical shipping drums and 2-in. threaded fittings. With range of one drop per min to ten gph, unit is ideal for open-vessel as well as suction-side (vacuum) line feeding.—Sterling E Norcross Co

Just circle key numbers on the Reader Service card, page 103, to get complete product story

### Pocket microscope checks, measures small parts

**93** • Microscope is no larger than a fountain pen, has glass-etched reticle to measure 1/10 x .001-in. divisions. It checks and measures small parts for detecting flaws, quality control. No calculations are necessary. — Edmund Scientific Company

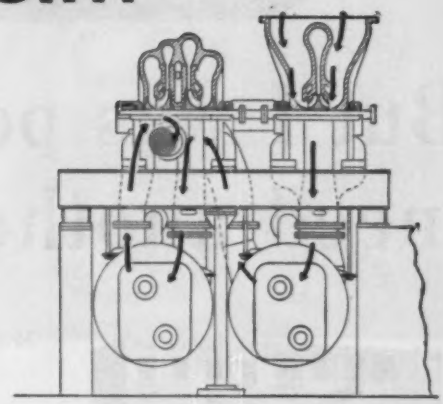
ANOTHER NEW DEVELOPMENT FROM INGERSOLL-RAND

Isometric drawing of new 60,000 cfm CVM compressor from discharge side—arranged for electric-motor drive through speed-increasing gear.

# NEW intercooled centrifugal compressor provides 100-125 psi air at capacities to 60,000 cfm

Ingersoll-Rand's new intercooled CVM centrifugal compressor is designed to provide high efficiency and low operating cost for 100-125 psi air at capacities from 30,000 to 60,000 cubic feet per minute. Utilizing the service-proved design principles of the 5-stage CVM compressor, introduced by Ingersoll-Rand last year for capacities to 35,000 cfm, the new unit extends the advantages of isothermal compression to *twice* the capacity heretofore available.

This new, larger unit features a double-suction first-stage impeller in a separate casing, with single-suction second and third stages in a second casing. Both casings are horizontally split for easy access, and each casing has a separate shaft. The use of separate casings and shafts permits most efficient aerodynamic design and enables both rotors to operate below first critical speed. Efficient water-cooled intercoolers suspended beneath the compressor remove heat of compression, approaching the ideal condition of isothermal operation and substantially reducing power requirements. Ask your Ingersoll-Rand engineer for complete information.



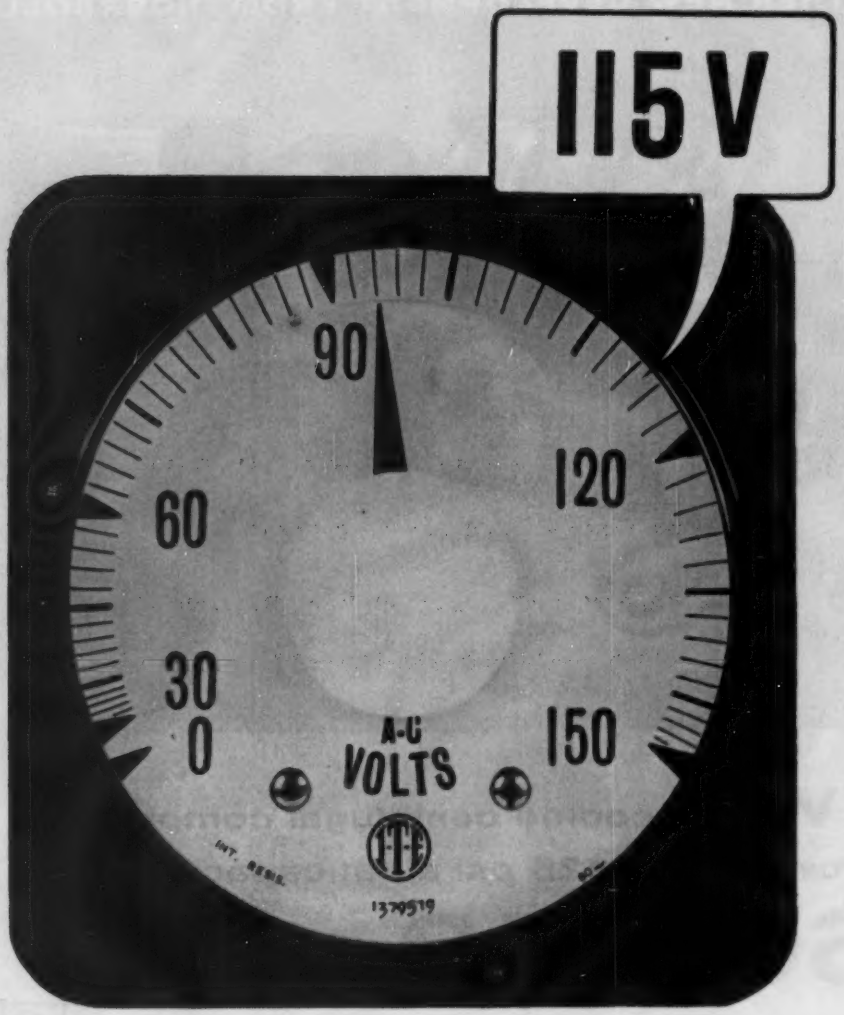
Side elevation with top half of casings cut away, showing air flow through compressor stages and intercoolers.

Ingersoll-Rand

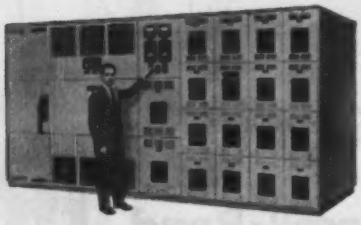
120-A-12 11 Broadway, New York 4, N. Y.

*THE WORLD'S MOST COMPREHENSIVE COMPRESSOR EXPERIENCE*

For more facts circle 286 on Reader Service card, p 103




# "But I was positive we didn't need another substation!"



**MORAL:** For good voltage regulation and better operating efficiency, put a secondary unit substation in each load area. And for complete information on today's most value-packed line of substations, write for Bulletin 3104-1A, I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton Street, Philadelphia 30, Pa.

**I-T-E CIRCUIT BREAKER COMPANY**



For more facts circle 287 on Reader Service card, p 103

COPPUS BLUE RIBBON PRODUCTS

Coppus Horizontal Steam Turbine

***NEW RUGGED DESIGN—BLUE RIBBON RELIABILITY!***
Here's a new dimension in turbine performance! Coppus brings you a new rugged stability of design . . . a new measure of reliability in a complete range of power-packed turbines, from 1 HP to 250 HP — marked with the Blue Ribbon only after each is precision made . . . precision tested. Performance features like these assure you Blue Ribbon Reliability —

*A totally enclosed governor . . . totally enclosed, independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.*

Coppus Turbines are built to customers' specifications, including API and NEMA standards. All Coppus Products carry the same Blue Ribbon assurance of reliable performance. For further facts on turbines, send for new Catalog 200. COPPUS ENGINEERING CORPORATION, 166 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

**COPPUS**
**STEAM TURBINES**

**For more facts circle 288 on Reader Service card, p 103**

By B G A SKROTZKI, Associate Editor

**To figure steam cycles we must know how to use the Steam Tables. Between Steam Tables and the Mollier chart we can minimize the amount of calculating work to be done**

# Steam Tables—storehouse of properties

Last month we met our first Steam Table for dry saturated steam arranged against even values of temperature in degrees F. The complete set of Steam Tables by Keenan and Keyes, published by John Wiley & Sons, also has a dry-saturated-steam table arranged against even values of pressure.

These two sets of tables make it easy to interpolate and find properties for uneven values of either pressure or temperature. For lack of space we won't reproduce an abstract of the pressure table.

The third set of tables, Table 1, right, lists properties of superheated steam against even values of both pressure and temperature. Three properties are listed for each state given by the pressure and the temperature: specific volume, $v$, cu ft per lb; enthalpy, $h$, Btu per lb; specific entropy, $s$, Btu per lb, F.

The complete Steam Tables for superheated steam cover a total of 36 pages. Table 1 is a very brief abstract of these. The figure in parentheses under each pressure is the saturation temperature for that pressure in degrees F.

**High-pressure table.** Recent work in superpressure cycles raised the need for extending the Steam Tables to 10,000 psia pressure. Until further experimental work is completed, interim tables were compiled by extrapolation and scattered data to this higher pressure. Table 2, p 160, is a brief abstract of the high-pressure table. This one has been extended over a range of temperatures from 32 to 1600 F. Some workers consider the fluid a compressed liquid below the critical temperature of 705.4 F, and superheated steam

| Abs press., psi (sat temp) | | Temp, F | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1400 | 1600 |
| 1 (101.74) | v | 392.6 | 452.3 | 512.0 | 571.6 | 631.2 | 690.8 | 750.4 | 809.9 | 869.5 | 929.1 | 988.7 | 1107.8 | 1227.0 |
| | h | 1150.4 | 1195.8 | 1241.7 | 1288.3 | 1335.7 | 1383.8 | 1432.8 | 1482.7 | 1533.5 | 1585.2 | 1637.7 | 1745.7 | 1857.5 |
| | s | 2.0512 | 2.1153 | 2.1730 | 2.2233 | 2.2702 | 2.3137 | 2.3542 | 2.3923 | 2.4283 | 2.4625 | 2.4952 | 2.5566 | 2.6137 |
| 5 (162.24) | v | 78.16 | 90.25 | 102.26 | 114.22 | 126.16 | 138.10 | 150.03 | 161.95 | 173.87 | 185.79 | 197.71 | 221.6 | 245.4 |
| | h | 1148.8 | 1195.0 | 1241.2 | 1288.0 | 1335.4 | 1383.6 | 1432.7 | 1482.6 | 1533.4 | 1585.1 | 1637.7 | 1745.7 | 1857.4 |
| | s | 1.8718 | 1.9370 | 1.9942 | 2.0456 | 2.0927 | 2.1361 | 2.1767 | 2.2148 | 2.2509 | 2.2851 | 2.3178 | 2.3792 | 2.4363 |
| 10 (193.21) | v | 38.85 | 45.00 | 51.04 | 57.05 | 63.03 | 69.01 | 74.98 | 80.95 | 86.92 | 92.88 | 98.84 | 110.77 | 122.69 |
| | h | 1146.6 | 1193.9 | 1240.6 | 1287.5 | 1335.1 | 1383.4 | 1432.5 | 1482.4 | 1533.2 | 1585.0 | 1637.6 | 1745.6 | 1857.3 |
| | s | 1.7927 | 1.8595 | 1.9172 | 1.9689 | 2.0160 | 2.0596 | 2.1002 | 2.1383 | 2.1744 | 2.2086 | 2.2413 | 2.3028 | 2.3598 |
| 14.696 (212.00) | v | | 30.53 | 34.68 | 38.78 | 42.85 | 46.94 | 51.00 | 55.07 | 59.13 | 63.19 | 67.25 | 75.37 | 83.48 |
| | h | | 1192.8 | 1239.9 | 1287.1 | 1334.8 | 1383.2 | 1432.3 | 1482.3 | 1533.1 | 1584.8 | 1637.5 | 1745.5 | 1857.3 |
| | s | | 1.8160 | 1.8743 | 1.9261 | 1.9734 | 2.0170 | 2.0576 | 2.0956 | 2.1319 | 2.1662 | 2.1989 | 2.2603 | 2.3174 |
| 20 (227.96) | v | | 22.36 | 25.43 | 28.46 | 31.47 | 34.47 | 37.46 | 40.45 | 43.44 | 46.42 | 49.41 | 55.37 | 61.34 |
| | h | | 1191.6 | 1239.2 | 1286.6 | 1334.4 | 1382.9 | 1432.1 | 1482.1 | 1533.0 | 1584.7 | 1637.4 | 1745.4 | 1857.2 |
| | s | | 1.7808 | 1.8396 | 1.8918 | 1.9392 | 1.9829 | 2.0235 | 2.0618 | 2.0978 | 2.1321 | 2.1648 | 2.2263 | 2.2834 |
| 40 (267.25) | v | | 11.040 | 12.628 | 14.168 | 15.688 | 17.198 | 18.702 | 20.20 | 21.70 | 23.20 | 24.69 | 27.68 | 30.66 |
| | h | | 1186.8 | 1236.5 | 1284.8 | 1333.1 | 1381.9 | 1431.3 | 1481.4 | 1532.4 | 1584.3 | 1637.0 | 1745.1 | 1857.0 |
| | s | | 1.6994 | 1.7608 | 1.8140 | 1.8619 | 1.9056 | 1.9457 | 1.9830 | 2.0212 | 2.0555 | 2.0883 | 2.1498 | 2.2069 |
| 60 (292.71) | v | | 7.259 | 8.357 | 9.403 | 10.427 | 11.441 | 12.449 | 13.452 | 14.454 | 15.453 | 16.451 | 18.446 | 20.44 |
| | h | | 1181.6 | 1233.0 | 1283.0 | 1331.8 | 1380.9 | 1430.5 | 1480.8 | 1531.9 | 1583.8 | 1636.8 | 1744.8 | 1856.7 |
| | s | | 1.6492 | 1.7135 | 1.7678 | 1.8162 | 1.8605 | 1.9015 | 1.9400 | 1.9762 | 2.0106 | 2.0434 | 2.1049 | 2.1621 |
| 80 (312.03) | v | | | 6.220 | 7.039 | 7.797 | 8.562 | 9.322 | 10.077 | 10.830 | 11.582 | 12.332 | 13.830 | 15.325 |
| | h | | | 1230.7 | 1281.1 | 1330.5 | 1379.9 | 1429.7 | 1480.1 | 1531.3 | 1583.4 | 1636.2 | 1744.5 | 1856.5 |
| | s | | | 1.6791 | 1.7346 | 1.7836 | 1.8281 | 1.8694 | 1.9079 | 1.9442 | 1.9787 | 2.0115 | 2.0731 | 2.1303 |
| 100 (327.81) | v | | | 4.937 | 5.589 | 6.218 | 6.835 | 7.446 | 8.052 | 8.656 | 9.259 | 9.860 | 11.060 | 12.256 |
| | h | | | 1227.6 | 1279.1 | 1329.1 | 1378.9 | 1428.9 | 1479.5 | 1530.8 | 1582.9 | 1635.7 | 1744.2 | 1856.2 |
| | s | | | 1.6518 | 1.7085 | 1.7581 | 1.8029 | 1.8443 | 1.8829 | 1.9193 | 1.9538 | 1.9867 | 2.0484 | 2.1056 |
| 120 (341.25) | v | | | 4.081 | 4.636 | 5.165 | 5.683 | 6.195 | 6.702 | 7.207 | 7.710 | 8.212 | 9.214 | 10.213 |
| | h | | | 1224.4 | 1277.2 | 1327.7 | 1377.8 | 1428.1 | 1478.8 | 1530.2 | 1582.4 | 1635.3 | 1743.9 | 1856.0 |
| | s | | | 1.6287 | 1.6869 | 1.7370 | 1.7822 | 1.8237 | 1.8625 | 1.8990 | 1.9335 | 1.9664 | 2.0281 | 2.0854 |
| 140 (353.02) | v | | | 3.468 | 3.954 | 4.413 | 4.861 | 5.301 | 5.738 | 6.172 | 6.604 | 7.035 | 7.895 | 8.752 |
| | h | | | 1221.1 | 1275.2 | 1326.4 | 1376.8 | 1427.3 | 1478.2 | 1529.7 | 1581.9 | 1634.9 | 1743.5 | 1855.7 |
| | s | | | 1.6087 | 1.6683 | 1.7190 | 1.7645 | 1.8063 | 1.8451 | 1.8817 | 1.9163 | 1.9493 | 2.0110 | 2.0683 |
| 160 (363.53) | v | | | 3.006 | 3.443 | 3.849 | 4.244 | 4.631 | 5.015 | 5.396 | 5.775 | 6.152 | 6.906 | 7.656 |
| | h | | | 1217.6 | 1273.1 | 1325.0 | 1375.7 | 1426.4 | 1477.5 | 1529.1 | 1581.4 | 1634.5 | 1743.2 | 1855.5 |
| | s | | | 1.5908 | 1.6519 | 1.7033 | 1.7491 | 1.7911 | 1.8301 | 1.8667 | 1.9014 | 1.9344 | 1.9962 | 2.0535 |
| 180 (373.06) | v | | | 2.649 | 3.044 | 3.411 | 3.764 | 4.110 | 4.452 | 4.792 | 5.129 | 5.466 | 6.136 | 6.804 |
| | h | | | 1214.0 | 1271.0 | 1323.5 | 1374.7 | 1425.6 | 1476.8 | 1528.6 | 1581.0 | 1634.1 | 1742.9 | 1855.2 |
| | s | | | 1.5745 | 1.6373 | 1.6894 | 1.7356 | 1.7776 | 1.8167 | 1.8534 | 1.8882 | 1.9212 | 1.9831 | 2.0404 |
| 200 (381.79) | v | | | 2.361 | 2.726 | 3.060 | 3.380 | 3.693 | 4.002 | 4.309 | 4.613 | 4.917 | 5.521 | 6.123 |
| | h | | | 1210.3 | 1268.9 | 1322.1 | 1372.6 | 1424.8 | 1476.2 | 1528.0 | 1580.5 | 1633.7 | 1742.6 | 1855.0 |
| | s | | | 1.5594 | 1.6240 | 1.6767 | 1.7232 | 1.7655 | 1.8048 | 1.8418 | 1.8763 | 1.9094 | 1.9713 | 2.0287 |
| 220 (389.86) | v | | | 2.125 | 2.465 | 2.772 | 3.066 | 3.352 | 3.634 | 3.913 | 4.191 | 4.467 | 5.017 | 5.565 |
| | h | | | 1206.5 | 1266.7 | 1320.7 | 1372.0 | 1424.0 | 1475.5 | 1527.5 | 1580.0 | 1633.3 | 1742.3 | 1854.7 |
| | s | | | 1.5453 | 1.6117 | 1.6653 | 1.7120 | 1.7545 | 1.7939 | 1.8308 | 1.8656 | 1.8987 | 1.9607 | 2.0181 |
| 240 (397.37) | v | | | 1.9276 | 2.247 | 2.533 | 2.804 | 3.068 | 3.327 | 3.584 | 3.839 | 4.093 | 4.597 | 5.100 |
| | h | | | 1202.5 | 1264.5 | 1319.2 | 1371.5 | 1423.2 | 1474.8 | 1526.9 | 1579.6 | 1632.9 | 1742.0 | 1854.5 |
| | s | | | 1.5319 | 1.6003 | 1.6546 | 1.7017 | 1.7444 | 1.7839 | 1.8209 | 1.8558 | 1.8889 | 1.9510 | 2.0084 |
| 260 (404.42) | v | | | | 2.063 | 2.330 | 2.582 | 2.827 | 3.067 | 3.305 | 3.541 | 3.776 | 4.242 | 4.707 |
| | h | | | | 1262.3 | 1317.7 | 1370.4 | 1422.3 | 1474.2 | 1526.3 | 1579.1 | 1632.5 | 1741.7 | 1854.2 |
| | s | | | | 1.5897 | 1.6447 | 1.6922 | 1.7352 | 1.7748 | 1.8118 | 1.8467 | 1.8799 | 1.9430 | 1.9995 |
| 280 (411.05) | v | | | | 1.9047 | 2.156 | 2.392 | 2.621 | 2.845 | 3.066 | 3.285 | 3.504 | 3.938 | 4.370 |
| | h | | | | 1260.0 | 1316.2 | 1369.4 | 1421.5 | 1473.5 | 1525.8 | 1578.6 | 1632.1 | 1741.4 | 1854.0 |
| | s | | | | 1.5796 | 1.6354 | 1.6834 | 1.7265 | 1.7662 | 1.8033 | 1.8383 | 1.8716 | 1.9337 | 1.9912 |
| 300 (417.33) | v | | | | 1.7675 | 2.005 | 2.227 | 2.442 | 2.652 | 2.859 | 3.065 | 3.269 | 3.674 | 4.078 |
| | h | | | | 1257.6 | 1314.7 | 1368.3 | 1420.6 | 1472.8 | 1525.2 | 1578.1 | 1631.7 | 1741.0 | 1853.7 |
| | s | | | | 1.5701 | 1.6268 | 1.6751 | 1.7184 | 1.7582 | 1.7954 | 1.8305 | 1.8638 | 1.9260 | 1.9835 |
| 350 (431.72) | v | | | | 1.4923 | 1.7036 | 1.8980 | 2.084 | 2.266 | 2.445 | 2.622 | 2.798 | 3.147 | 3.493 |
| | h | | | | 1251.5 | 1310.9 | 1365.5 | 1418.5 | 1471.1 | 1523.8 | 1577.0 | 1630.7 | 1740.3 | 1853.1 |
| | s | | | | 1.5481 | 1.6070 | 1.6563 | 1.7002 | 1.7403 | 1.7777 | 1.8130 | 1.8463 | 1.9098 | 1.9683 |
| 400 (444.59) | v | | | | 1.2851 | 1.4770 | 1.6508 | 1.8161 | 1.9767 | 2.134 | 2.290 | 2.445 | 2.751 | 3.055 |
| | h | | | | 1245.1 | 1306.9 | 1362.7 | 1416.4 | 1469.4 | 1522.4 | 1575.8 | 1629.6 | 1739.5 | 1852.5 |
| | s | | | | 1.5281 | 1.5894 | 1.6398 | 1.6842 | 1.7247 | 1.7623 | 1.7977 | 1.8311 | 1.8936 | 1.9513 |

Abridged from *Thermodynamic Properties of Steam* by Joseph H Keenan and Frederick G Keyes, John Wiley & Sons, Inc, New York, 1937

**1—Thermodynamic properties of superheated**

above. This is purely arbitrary since superheat has no real meaning when no saturation temperature applies.

Table 2, a new effort, was made to include properties way down to 32 F, usually called the compressed-liquid region. Table 1 for superheated steam does not list properties below 200 F for the lower pressures and below 700 F for the higher pressures. To get these, Keenan and Keyes' Steam Tables include a table for compressed liquid. This is a correction table that can be applied to the listed properties for the saturated liquid to figure properties in the subcooled or compressed state.

**Saturation table.** Tables 1 and 2 are relatively easy to use. But the saturation tables, such as in Part 38, May 1960, p 150-152, need a little study and practice. So get out your May POWER, or a copy of the Keenan and Keyes Steam Tables, and find out what it's all about.

For example, at 200 F there is only one saturation pressure $p$, 11.526 psia. Specific volume of the saturated liquid $v_f$ is 0.01663 cu ft per lb. Specific volume added by vaporization $v_{fg}$ is 33.62 cu ft per lb. Specific volume of the saturated vapor $v_g$ is 33.64 cu ft per lb. Note that $v_g = v_f + v_{fg}$.

Reading across to the enthalpy group of columns we find $h_g = h_f + h_{fg}$. Substituting for 200 F this works out to 1145.9 Btu per lb = 167.99 + 977.9. In words, enthalpy of the saturated vapor equals sum of the enthalpy of the saturated liquid and the enthalpy of vaporization.

We have a like relation for entropy. Entropy of the vapor equals sum of the entropy of the saturated liquid and entropy of vaporization; $s_g = s_f + s_{fg}$. At 200 F we see that 1.7762 = 0.2938 + 1.4824.

Saturation table for pressure in the Keenan and Keyes tables also contains a set of columns for internal energy defined by $u_g = u_f + u_{fg}$. From the basic definition we can also calculate $u_g = h_g - (pv_g/J)$. Pressure would be the saturation pressure corresponding to the particular saturation temperature.

Since the steam table is based on zero enthalpy and zero entropy at 32 F and 0.8854 psia, it follows that internal energy at 32 F must be a negative quantity. This difference, however, is so small because of the low pressure that for practical engineering purposes we can usually figure internal energy at 32 F and nearby range as equal to the enthalpy.

**Wet mixtures.** Many steam processes involve a mixture of saturated steam and saturated liquid. The liquid usually appears as a mist or fog in these processes for relatively dry mixtures; or as steam bubbles in water for relatively wet mixtures.

These mixtures are measured either by *percent moisture*, $y$, or by *percent quality*, $x$. These factors are defined by:

$x = [w_g/(w_g + w_f)] \times 100$ and

$y = [w_f/(w_g + w_f)] \times 100$

$100 = x + y$ where:

$w_g$ = weight of steam in mixture

$w_f$ = weight of liquid in mixture

To find the properties of a mixture we must know the moisture or quality. Then any of the properties may be found by:

| | |
|---|---|
| $v = v_g - yv_{fg}/100$ | cu ft per lb |
| $v = v_f + xv_{fg}/100$ | cu ft per lb |
| $h = h_g - yh_{fg}/100$ | Btu per lb |
| $h = h_f + xh_{fg}/100$ | Btu per lb |
| $s = s_g - ys_{fg}/100$ | Btu per lb, F |
| $s = s_f + xs_{fg}/100$ | Btu per lb, F |

continued

| Abs press., psi (sat temp) | | Temp, F | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 500 | 550 | 600 | 620 | 640 | 660 | 680 | 700 | 800 | 900 | 1000 | 1200 | 1400 | 1600 |
| | v | 1.1231 | 1.2155 | 1.3005 | 1.3332 | 1.3652 | 1.3967 | 1.4278 | 1.4584 | 1.6074 | 1.7516 | 1.8928 | 2.170 | 2.443 | 2.714 |
| 450 | h | 1238.4 | 1272.0 | 1302.8 | 1314.6 | 1326.2 | 1337.5 | 1348.8 | 1359.9 | 1414.3 | 1467.7 | 1521.0 | 1628.6 | 1738.7 | 1851.9 |
| (456.28) | s | 1.5095 | 1.5437 | 1.5735 | 1.5845 | 1.5951 | 1.6054 | 1.6153 | 1.6250 | 1.6699 | 1.7108 | 1.7486 | 1.8177 | 1.8803 | 1.9381 |
| | v | 0.9827 | 1.0800 | 1.1691 | 1.1993 | 1.2289 | 1.2478 | 1.2763 | 1.3044 | 1.4405 | 1.5715 | 1.6996 | 1.9504 | 2.197 | 2.442 |
| 500 | h | 1231.3 | 1266.8 | 1298.6 | 1310.7 | 1322.6 | 1334.2 | 1345.7 | 1357.0 | 1412.1 | 1466.0 | 1519.6 | 1627.6 | 1737.9 | 1851.3 |
| (467.01) | s | 1.4919 | 1.5280 | 1.5588 | 1.5701 | 1.5810 | 1.5915 | 1.6016 | 1.6115 | 1.6571 | 1.6982 | 1.7363 | 1.8056 | 1.8683 | 1.9262 |
| | v | 0.8852 | 0.9686 | 1.0431 | 1.0714 | 1.0989 | 1.1259 | 1.1523 | 1.1783 | 1.3038 | 1.4241 | 1.5414 | 1.7706 | 1.9957 | 2.219 |
| 550 | h | 1233.7 | 1261.2 | 1294.3 | 1306.8 | 1318.9 | 1330.8 | 1342.5 | 1354.0 | 1409.9 | 1464.3 | 1518.2 | 1626.6 | 1737.1 | 1850.6 |
| (476.94) | s | 1.4781 | 1.5131 | 1.5451 | 1.5568 | 1.5680 | 1.5787 | 1.5890 | 1.5991 | 1.6432 | 1.6828 | 1.7280 | 1.7946 | 1.8575 | 1.9155 |
| | v | 0.7947 | 0.8753 | 0.9463 | 0.9729 | 0.9988 | 1.0241 | 1.0489 | 1.0732 | 1.1899 | 1.3013 | 1.4096 | 1.6208 | 1.8279 | 2.033 |
| 600 | h | 1218.7 | 1256.5 | 1289.9 | 1302.7 | 1315.2 | 1327.4 | 1339.3 | 1351.1 | 1407.7 | 1462.5 | 1516.7 | 1625.5 | 1736.3 | 1850.0 |
| (486.21) | s | 1.4586 | 1.4990 | 1.5323 | 1.5443 | 1.5556 | 1.5667 | 1.5773 | 1.5875 | 1.6343 | 1.6762 | 1.7147 | 1.7846 | 1.8476 | 1.9056 |
| | v | ..... | 0.7277 | 0.7934 | 0.8177 | 0.8411 | 0.8639 | 0.8860 | 0.9077 | 0.9108 | 1.1082 | 1.2024 | 1.3853 | 1.5641 | 1.7405 |
| 700 | h | ..... | 1243.2 | 1280.6 | 1294.3 | 1307.5 | 1320.3 | 1332.8 | 1345.0 | 1403.2 | 1459.0 | 1515.9 | 1623.5 | 1734.8 | 1848.8 |
| (503.10) | s | ..... | 1.4722 | 1.5084 | 1.5212 | 1.5333 | 1.5449 | 1.5559 | 1.5665 | 1.6147 | 1.6573 | 1.6963 | 1.7666 | 1.8299 | 1.8881 |
| | v | ..... | 0.6184 | 0.6779 | 0.7006 | 0.7223 | 0.7433 | 0.7635 | 0.7833 | 0.8763 | 0.9633 | 1.0470 | 1.2088 | 1.3662 | 1.5214 |
| 800 | h | ..... | 1229.8 | 1270.7 | 1285.4 | 1299.4 | 1312.9 | 1325.9 | 1338.6 | 1398.6 | 1455.4 | 1511.0 | 1621.4 | 1733.2 | 1847.5 |
| (518.23) | s | ..... | 1.4467 | 1.4863 | 1.5000 | 1.5129 | 1.5250 | 1.5366 | 1.5476 | 1.5972 | 1.6407 | 1.6801 | 1.7510 | 1.8146 | 1.8729 |
| | v | ..... | 0.5264 | 0.5873 | 0.6089 | 0.6294 | 0.6491 | 0.6680 | 0.6863 | 0.7716 | 0.8506 | 0.9262 | 1.0714 | 1.2124 | 1.3509 |
| 900 | h | ..... | 1215.0 | 1260.1 | 1278.9 | 1290.9 | 1305.1 | 1318.8 | 1332.1 | 1393.9 | 1451.8 | 1508.1 | 1619.3 | 1731.6 | 1846.3 |
| (531.98) | s | ..... | 1.4216 | 1.4653 | 1.4800 | 1.4938 | 1.5066 | 1.5187 | 1.5303 | 1.5814 | 1.6257 | 1.6656 | 1.7371 | 1.8009 | 1.8595 |
| | v | ..... | 0.4533 | 0.5140 | 0.5350 | 0.5546 | 0.5733 | 0.5912 | 0.6084 | 0.6878 | 0.7604 | 0.8294 | 0.9615 | 1.0893 | 1.2146 |
| 1000 | h | ..... | 1198.3 | 1248.8 | 1265.9 | 1281.9 | 1297.0 | 1311.4 | 1325.3 | 1389.2 | 1448.2 | 1505.1 | 1617.3 | 1730.0 | 1845.0 |
| (544.61) | s | ..... | 1.3961 | 1.4430 | 1.4610 | 1.4757 | 1.4893 | 1.5021 | 1.5141 | 1.5670 | 1.6121 | 1.6525 | 1.7245 | 1.7886 | 1.8474 |
| | v | ..... | ..... | 0.4532 | 0.4728 | 0.4929 | 0.5110 | 0.5281 | 0.5445 | 0.6191 | 0.6866 | 0.7503 | 0.8716 | 0.9885 | 1.1031 |
| 1100 | h | ..... | ..... | 1236.7 | 1255.3 | 1272.4 | 1288.5 | 1303.7 | 1318.3 | 1384.3 | 1444.5 | 1502.2 | 1615.2 | 1728.4 | 1843.8 |
| (556.31) | s | ..... | ..... | 1.4251 | 1.4425 | 1.4583 | 1.4728 | 1.4862 | 1.4989 | 1.5535 | 1.5995 | 1.6405 | 1.7130 | 1.7775 | 1.8363 |
| | v | ..... | ..... | 0.4016 | 0.4222 | 0.4410 | 0.4586 | 0.4752 | 0.4909 | 0.5617 | 0.6250 | 0.6843 | 0.7967 | 0.9046 | 1.0101 |
| 1200 | h | ..... | ..... | 1223.5 | 1243.9 | 1262.4 | 1279.6 | 1295.7 | 1311.0 | 1379.3 | 1440.7 | 1499.2 | 1613.1 | 1726.9 | 1842.5 |
| (567.22) | s | ..... | ..... | 1.4052 | 1.4243 | 1.4413 | 1.4568 | 1.4710 | 1.4843 | 1.5409 | 1.5879 | 1.6293 | 1.7025 | 1.7672 | 1.8263 |
| | v | ..... | ..... | 0.3174 | 0.3390 | 0.3580 | 0.3753 | 0.3912 | 0.4062 | 0.4714 | 0.5281 | 0.5805 | 0.6789 | 0.7727 | 0.8640 |
| 1400 | h | ..... | ..... | 1193.0 | 1218.4 | 1240.4 | 1260.3 | 1278.5 | 1295.5 | 1369.1 | 1433.1 | 1493.2 | 1608.9 | 1723.7 | 1840.0 |
| (587.10) | s | ..... | ..... | 1.3639 | 1.3877 | 1.4079 | 1.4256 | 1.4419 | 1.4567 | 1.5177 | 1.5666 | 1.6093 | 1.6836 | 1.7489 | 1.8083 |
| | v | ..... | ..... | ..... | 0.2733 | 0.2936 | 0.3112 | 0.3271 | 0.3417 | 0.4034 | 0.4553 | 0.5027 | 0.5906 | 0.6738 | 0.7545 |
| 1600 | h | ..... | ..... | ..... | 1187.8 | 1215.2 | 1238.7 | 1259.6 | 1278.7 | 1358.4 | 1425.3 | 1487.0 | 1604.6 | 1720.5 | 1837.5 |
| (604.90) | s | ..... | ..... | ..... | 1.3489 | 1.3741 | 1.3962 | 1.4137 | 1.4303 | 1.4964 | 1.5476 | 1.5914 | 1.6669 | 1.7328 | 1.7926 |
| | v | ..... | ..... | ..... | ..... | 0.2407 | 0.2597 | 0.2760 | 0.2907 | 0.3502 | 0.3986 | 0.4421 | 0.5218 | 0.5968 | 0.6693 |
| 1800 | h | ..... | ..... | ..... | ..... | 1185.1 | 1214.0 | 1238.5 | 1260.3 | 1347.2 | 1417.4 | 1480.8 | 1600.4 | 1717.3 | 1835.0 |
| (621.03) | s | ..... | ..... | ..... | ..... | 1.3377 | 1.3638 | 1.3855 | 1.4044 | 1.4763 | 1.5301 | 1.5782 | 1.6520 | 1.7185 | 1.7786 |
| | v | ..... | ..... | ..... | ..... | 0.1936 | 0.2161 | 0.2337 | 0.2489 | 0.3074 | 0.3532 | 0.3935 | 0.4688 | 0.5382 | 0.6011 |
| 2000 | h | ..... | ..... | ..... | ..... | 1145.6 | 1184.9 | 1214.8 | 1240.0 | 1336.5 | 1409.2 | 1474.5 | 1596.1 | 1714.1 | 1832.5 |
| (635.82) | s | ..... | ..... | ..... | ..... | 1.2945 | 1.3300 | 1.3564 | 1.3793 | 1.4576 | 1.5139 | 1.5603 | 1.6384 | 1.7058 | 1.7660 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | 0.1484 | 0.1686 | 0.2294 | 0.2710 | 0.3061 | 0.3678 | 0.4244 | 0.4784 |
| 2500 | h | ..... | ..... | ..... | ..... | ..... | ..... | 1132.3 | 1176.8 | 1303.6 | 1387.8 | 1458.4 | 1585.3 | 1706.1 | 1826.2 |
| (668.13) | s | ..... | ..... | ..... | ..... | ..... | ..... | 1.2687 | 1.3073 | 1.4127 | 1.4772 | 1.5273 | 1.6088 | 1.6775 | 1.7389 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.0984 | 0.1760 | 0.2159 | 0.2476 | 0.3018 | 0.3505 | 0.3966 |
| 3000 | h | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1060.7 | 1267.2 | 1365.0 | 1441.8 | 1574.3 | 1698.0 | 1819.9 |
| (695.36) | s | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1.1966 | 1.3690 | 1.4439 | 1.4984 | 1.5837 | 1.6540 | 1.7163 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.1583 | 0.1981 | 0.2288 | 0.2806 | 0.3267 | 0.3703 |
| 3206.2 | h | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1250.5 | 1355.2 | 1434.7 | 1569.8 | 1694.6 | 1817.2 |
| (705.40) | s | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 1.3508 | 1.4309 | 1.4874 | 1.5742 | 1.6452 | 1.7080 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.0306 | 0.1364 | 0.1762 | 0.2058 | 0.2546 | 0.2977 | 0.3381 |
| 3500 | h | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 780.5 | 1224.9 | 1340.7 | 1424.5 | 1563.3 | 1689.8 | 1813.6 |
| | s | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.9515 | 1.3241 | 1.4127 | 1.4733 | 1.5615 | 1.6336 | 1.6968 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.0287 | 0.1052 | 0.1462 | 0.1743 | 0.2192 | 0.2581 | 0.2943 |
| 4000 | h | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 763.8 | 1174.8 | 1314.4 | 1406.8 | 1552.1 | 1681.7 | 1807.2 |
| | s | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.9347 | 1.2787 | 1.3827 | 1.4482 | 1.5417 | 1.6154 | 1.6795 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.0276 | 0.0798 | 0.1226 | 0.1500 | 0.1917 | 0.2273 | 0.2602 |
| 4500 | h | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 753.5 | 1113.9 | 1286.5 | 1388.4 | 1540.8 | 1673.5 | 1800.9 |
| | s | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.9235 | 1.2304 | 1.3529 | 1.4253 | 1.5235 | 1.5990 | 1.6640 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.0268 | 0.0593 | 0.1036 | 0.1303 | 0.1696 | 0.2027 | 0.2329 |
| 5000 | h | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 746.4 | 1047.1 | 1256.5 | 1369.5 | 1529.5 | 1665.3 | 1794.5 |
| | s | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.9152 | 1.1622 | 1.3231 | 1.4034 | 1.5066 | 1.5839 | 1.6499 |
| | v | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.0262 | 0.0463 | 0.0680 | 0.1143 | 0.1516 | 0.1825 | 0.2106 |
| 5500 | h | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 741.3 | 985.0 | 1224.1 | 1349.3 | 1518.2 | 1657.0 | 1788.1 |
| | s | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.9090 | 1.1093 | 1.2930 | 1.3821 | 1.4908 | 1.5699 | 1.6369 |

Abridged from *Thermodynamic Properties of Steam* by Joseph H Keenan and Frederick G Keyes, John Wiley & Sons, Inc. New York, 1937

**steam from 1- to 5500-psia pressure**

## 2—Thermodynamic properties of steam at 6000 to 10,000 psia*

| Press., psia | | Temp, F | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 32 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 |
| 6000 | v | 0.01570 | 0.01585 | 0.01633 | 0.01706 | 0.01805 | 0.01947 | 0.02160 | 0.0257 | 0.0402 | 0.0755 | 0.1013 | 0.1207 | 0.1370 | 0.1518 | 0.1660 | 0.1794 | 0.1924 |
| | h | 17.61 | 83.66 | 181.6 | 280.9 | 382.5 | 488.6 | 603.1 | 737.2 | 944.9 | 1192.5 | 1330.5 | 1427.2 | 1507.7 | 1578.4 | 1648.1 | 1715.2 | 1781.8 |
| | s | 0.00010 | 0.12576 | 0.28681 | 0.43695 | 0.58241 | 0.66904 | 0.78249 | 0.9032 | 1.0744 | 1.2642 | 1.3622 | 1.4263 | 1.4765 | 1.5168 | 1.5564 | 1.5908 | 1.6247 |
| 7000 | v | 0.01566 | 0.01581 | 0.01628 | 0.01699 | 0.01798 | 0.01935 | 0.02133 | 0.0248 | 0.0339 | 0.0577 | 0.0815 | 0.0997 | 0.1147 | 0.1282 | 0.1408 | 0.1528 | 0.1643 |
| | h | 20.45 | 86.22 | 183.9 | 282.9 | 383.9 | 489.4 | 602.0 | 730.4 | 899.4 | 1132.0 | 1290.4 | 1398.7 | 1485.8 | 1559.8 | 1631.7 | 1700.8 | 1769.4 |
| | s | 0.00002 | 0.12510 | 0.28574 | 0.42840 | 0.58024 | 0.66604 | 0.77771 | 0.8930 | 1.0328 | 1.2108 | 1.2333 | 1.3951 | 1.4494 | 1.4916 | 1.5324 | 1.5679 | 1.6027 |
| 8000 | v | 0.01561 | 0.01577 | 0.01623 | 0.01693 | 0.01790 | 0.01924 | 0.02112 | 0.0242 | 0.0304 | 0.0458 | 0.0673 | 0.0844 | 0.0985 | 0.1108 | 0.1224 | 0.1331 | 0.1435 |
| | h | 23.27 | 88.78 | 186.2 | 284.9 | 385.4 | 490.2 | 601.3 | 724.6 | 875.9 | 1074.4 | 1250.8 | 1369.8 | 1463.9 | 1541.5 | 1616.0 | 1688.7 | 1757.1 |
| | s | 0.00017 | 0.12446 | 0.28467 | 0.42388 | 0.54812 | 0.66317 | 0.77328 | 0.8845 | 1.0099 | 1.1614 | 1.2867 | 1.3687 | 1.4243 | 1.4686 | 1.5109 | 1.5472 | 1.5830 |
| 9000 | v | 0.01556 | 0.01572 | 0.01618 | 0.01686 | 0.01783 | 0.01914 | 0.02095 | 0.0238 | 0.0284 | 0.0393 | 0.0568 | 0.0726 | 0.0860 | 0.0974 | 0.1081 | 0.1181 | 0.1276 |
| | h | 26.07 | 91.33 | 188.5 | 286.9 | 386.9 | 491.0 | 600.8 | 721.0 | 861.8 | 1036.3 | 1213.2 | 1340.8 | 1442.0 | 1523.7 | 1600.5 | 1673.0 | 1745.6 |
| | s | 0.00034 | 0.12381 | 0.28362 | 0.42238 | 0.54602 | 0.66036 | 0.76909 | 0.8775 | 0.9930 | 1.1271 | 1.2531 | 1.3378 | 1.4006 | 1.4478 | 1.4911 | 1.5284 | 1.5632 |
| 10,000 | v | 0.01552 | 0.01568 | 0.01614 | 0.01682 | 0.01776 | 0.01904 | 0.02080 | 0.0234 | 0.0275 | 0.0353 | 0.0495 | 0.0635 | 0.0760 | 0.0872 | 0.0969 | 0.1061 | 0.1149 |
| | h | 28.84 | 93.88 | 190.8 | 288.9 | 388.5 | 491.9 | 600.4 | 718.4 | 853.3 | 1012.9 | 1181.0 | 1313.3 | 1419.7 | 1507.4 | 1585.5 | 1660.3 | 1734.7 |
| | s | 0.00054 | 0.12317 | 0.28257 | 0.42089 | 0.54396 | 0.65759 | 0.76517 | 0.8714 | 0.9832 | 1.1050 | 1.2243 | 1.3122 | 1.3784 | 1.4286 | 1.4729 | 1.5108 | 1.5491 |

* The complete Interim Steam Table prepared by the Subcommittee on Interim Steam Tables of the ASME Power Div is available from ASME, 29 West 39th St., New York 18, N. Y., at $1

## 3—Thermodynamic properties of Biphenyl (Monsanto)

| Temp, | Press., | Density, lb per cu ft | | Enthalpy, Btu per lb | | |
|---|---|---|---|---|---|---|
| F | psia | Liquid | Vapor | Liquid | Latent | Vapor |
| t | p | $1/v_f$ | $1/v_g$ | $h_f$ | $h_{fg}$ | $h_g$ |
| 156.6 | 0.015 | 61.93 | —— | 0.0 | 190.9 | 190.9 |
| 200 | 0.060 | 60.85 | 0.00108 | 17.7 | 175.0 | 192.7 |
| 300 | 0.701 | 58.08 | 0.0117 | 61.9 | 154.0 | 215.9 |
| 400 | 4.20 | 55.24 | 0.0616 | 112.6 | 148.0 | 260.6 |
| 500 | 16.3 | 52.32 | 0.236 | 171.0 | 135.0 | 306.0 |
| 600 | 47.0 | 49.04 | 0.750 | 234.8 | 117.0 | 351.8 |
| 700 | 110.1 | 45.38 | 1.730 | 301.5 | 103.0 | 404.5 |
| 800 | 221.8 | 40.89 | 3.355 | 369.6 | 91.5 | 461.1 |
| 900 | 399.7 | 34.58 | 6.850 | 438.4 | 67.5 | 505.9 |
| 980 | 607.0 | 19.60 | 19.600 | 493.7 | 0.0 | 493.7 |

These formulas show why the volume, enthalpy and entropy of vaporization are given in the saturation tables. They permit rapid calculation of wet mixtures.

**Compressed liquid.** For modern-steam-station pressures running around 2000 psia and up, the compressed-liquid region must be treated with care in figuring cycles if great accuracy is needed. Complete steam table for high pressures gives us this directly, Table 2. But the accepted steam tables for pressures below 5500 psia do not. To make this correction we use Keenan and Keyes' Table 4 for compressed liquids (not shown).

Suppose we wanted to get accurate values for water at 2000 psia and 400 F. From Keenan and Keyes' Table 4 we would find that the saturated liquid at this temperature had $v_f$ = 0.018639 cu ft per lb; $h_f$ = 374.97 Btu per lb and $s_f$ = 0.56638 Btu per lb, F. For rough work we'd use the saturated values. For accuracy we must apply the corrections given in the table.

At 400 F and 2000 psia we find these items in the table:

$(v - v_f)10^5$ $-19.5$

$(h - h_f)$ $+2.03$

$(s - s_f)10^3$ $-4.57$

Then the accurate values are:

$v = (-19.5/10^5) + v_f$

$= -0.000195 + 0.018639$

$= 0.018444$ cu ft per lb

$h = 2.03 + h_f$

$= 2.03 + 374.97$

$= 377.00$ Btu per lb

$s = (-4.57/10^3) + s_f$

$= -0.00457 + 0.56638$

$= 0.56181$ Btu per lb, F

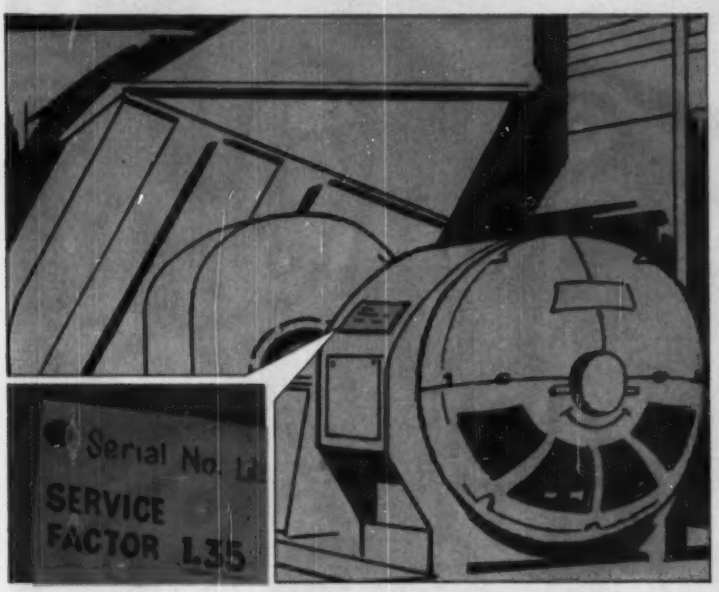
For this state we see that compressed-liquid values differ in the third place from saturated-liquid state at the given temperature.

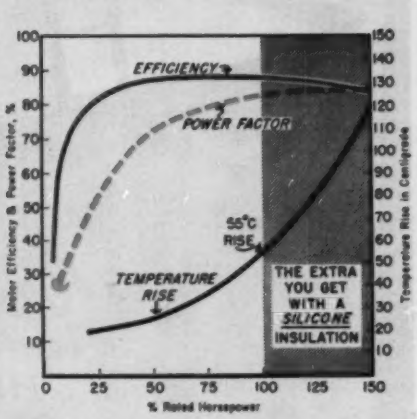
**Organic vapors.** Many vapors are used in modern heat cycles. Table 3 lists some of the properties of Biphenyl, a compound receiving attention in the nuclear-plant field. Note how properties differ radically from those of water. Biphenyl has both higher fusion and higher critical pressures and temperatures. For some situations this may offer important physical as well as thermodynamic advantages.

*Next month we will study thermodynamic processes using vapors.*

**SILICONE NEWS from Dow Corning**

# Economy vs Reliability?




## You Get Both When You Specify High Service Factor Motors for Auxiliary Drives

Motors built to entirely new design concepts are now available from leading manufacturers! They *look* like other motors. But they differ radically in performance . . . they'll carry overloads of fifteen to fifty percent *above* nameplate horsepower rating. They're insulated with Dow Corning Silicones for increased service factor!

### THIS INCREASED SERVICE FACTOR:

1. ***Simplifies Motor Specifications.*** With increased service factor motors, you can match nameplate horsepower ratings to nominal loads . . . these motors are well-equipped to handle temporary, or even continuous overloads. Generally, there's no need to calculate maximum loads. All the safety factor that motors normally need . . . even for fan and pump loads . . . is already built-in!

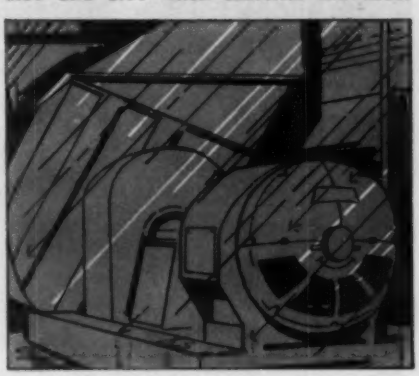
2. ***Reduces the Cost of Horsepower.*** With motors rated to average loads, the total installed horsepower is substantially less . . . and it costs less! If accepted application engineering practices are followed, additional savings result from lowered transformer and switchgear requirements . . . motor mounts and accessories cost less . . . and motors are easier to install.

3. ***Increases Reliability.*** In addition to increased service factor, thermally stable Dow Corning silicone insulation assures motor reliability in the high ambient areas near boilers, stacks, and high temperature processing equipment.

*For more information* on what silicone insulated service factor motors can mean to you, write Dept. 7006.

How do manufacturers build so much extra into a motor? By substituting an insulation system made from Dow Corning Silicones for the Class A insulation systems used in standard lines. Only the insulation is changed. Frame, electrical steel and copper remain the same. And there's one change on the nameplate—*service factor rating goes up!*

On a TEFC motor, for example, service factor goes up from 1.00 with Class A insulation materials to somewhere between 1.15 and 1.50 when silicones are used.



***Simplify Enclosures.*** You can also save by specifying silicone-insulated motors for outdoor service. The reason: "Self-protecting" insulation systems made with Silastic®, the Dow Corning silicone rubber, require no premium priced enclosures. You can specify open frames. No need to protect the insulation against outdoor elements.

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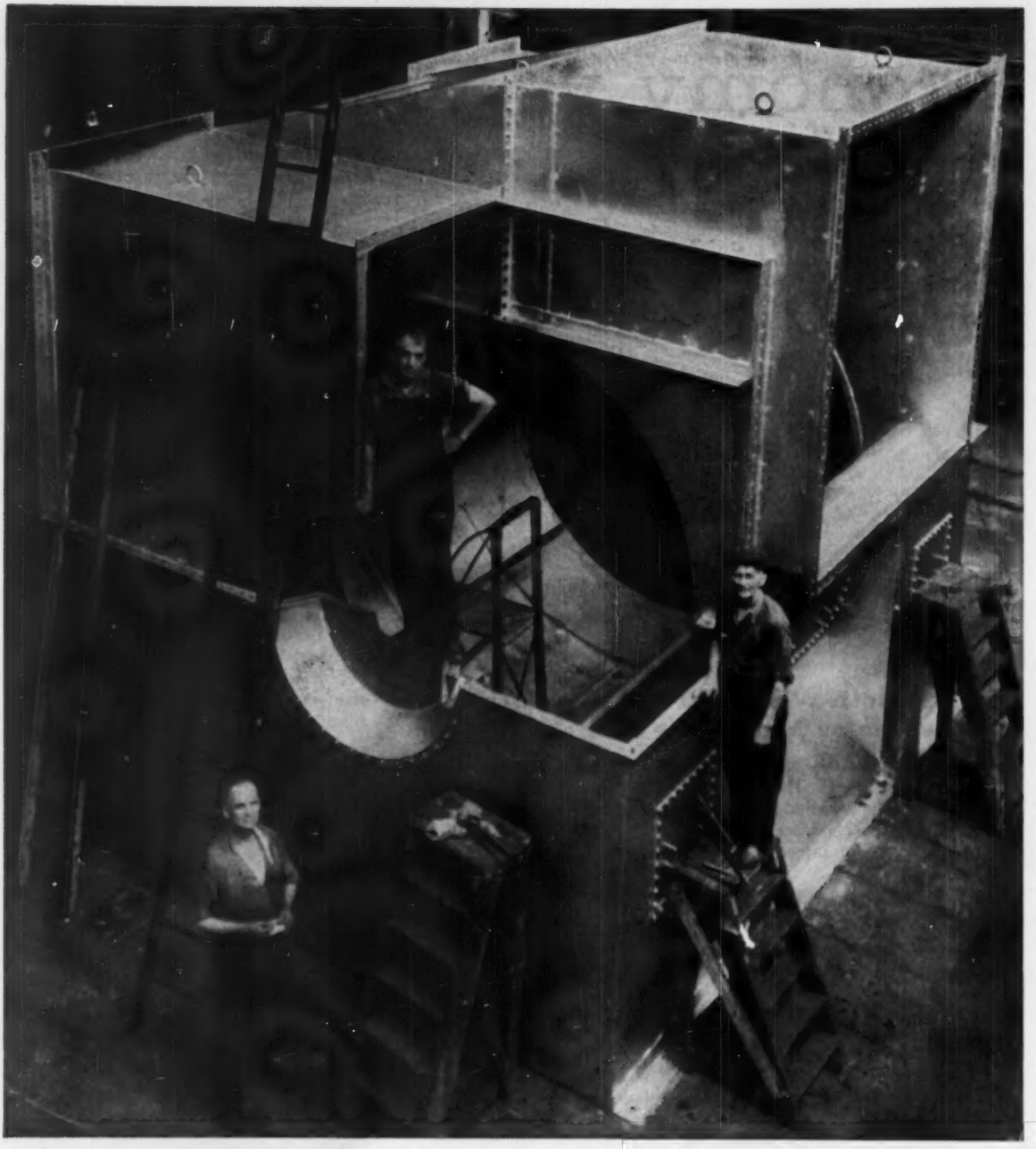
For more facts circle 289 on Reader Service card, p 103



**You wouldn't buy a bargain basement parachute... or a cut-rate big game rifle...**

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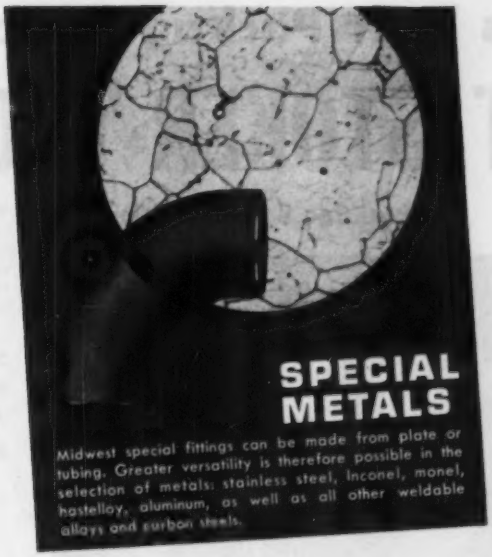
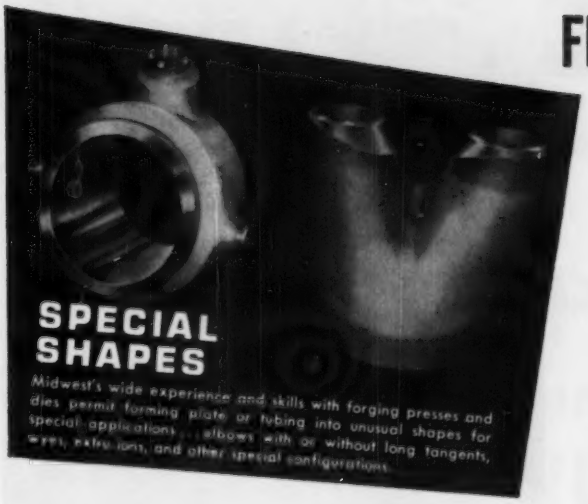
For more facts circle 290 on Reader Service card, p 103



**SPECIAL METALS**

Midwest special fittings can be made from plate or tubing. Greater versatility is therefore possible in the selection of metals: stainless steel, Inconel, monel, hastelloy, aluminum, as well as all other weldable alloys and carbon steels.

# MIDWEST SPECIAL FITTINGS MADE BY FITTING SPECIALISTS TO YOUR SPECIAL REQUIREMENTS



**SPECIAL SHAPES**

Midwest's wide experience and skills with forging presses and dies permit forming plate or tubing into unusual shapes for special applications . . . elbows with or without long tangents, weld, extensions, and other special configurations.

*For special fittings with any or all of the above characteristics, contact your local Midwest distributor . . . or call:*

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MIDWEST PIPING COMPANY, INC.
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**SPECIAL THICKNESS**

Wall thicknesses in a wide range of sizes are available in Midwest special fittings, up to 4", or more in carbon steel and a wide variety of alloys . . . stainless steel, Inconel, titanium, and others.

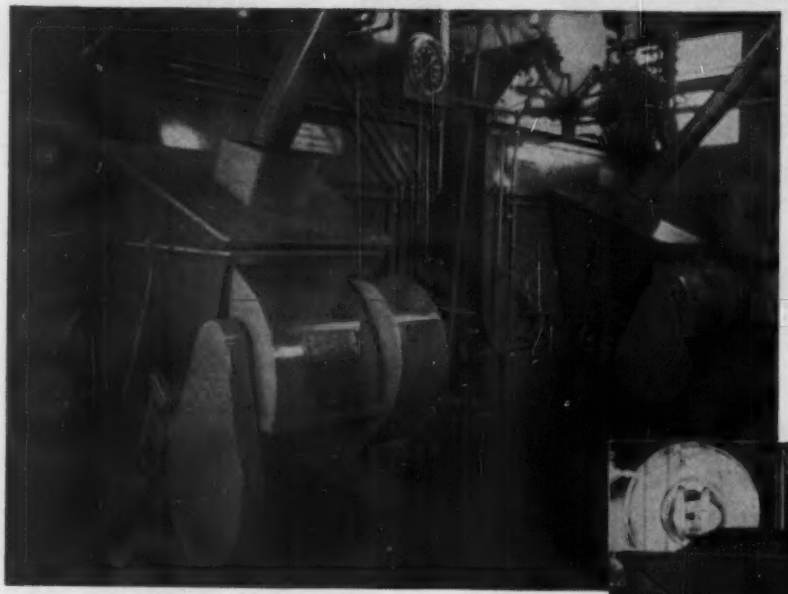


For more facts circle 291 on Reader Service card, p 103

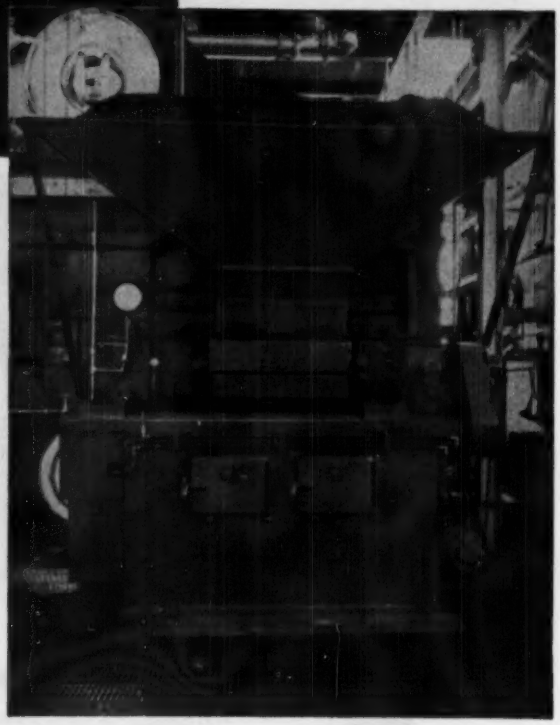
# Does Your Package* Include

# DETROIT STOKER ECONOMY?

***Package Boilers, of Course**



Detroit LoStokers firing two Wickes Package Boilers, Type A.O. continuous rating—6000 pounds steam per hour.



As the installation convenience of the package boiler is more and more widely appreciated, the question often is asked "Why can't we have the advantages of a package boiler with the economy of efficient coal firing?"

The answer is—you can. Water tube package boilers designed for stoker firing are readily available.

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The Detroit Stoker line includes a number of types specially adapted to package boilers.

DETROIT STOKERS COST LESS . . . COST EQUALS INITIAL INVESTMENT PLUS UPKEEP PLUS PRODUCTION LOSSES DUE TO EQUIPMENT OUTAGE. THE TOTAL IS LESS WITH DETROIT.

Ask for details on Detroit Stokers with package or other boilers.

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For more facts circle 293 on Reader Service card, p 103

"Leaving that cafeteria I noticed a Coke machine," roared Marmaduke Surfaceblow

# Marmy tames Old Faithful

One interesting thing about being an editor is that so many of my former shipmates know where I am. Yesterday Carl Frick, port engineer for the Black Diamond Lines, called. Said he enjoyed *Marmy's continuous monitor* in the February issue so much that he wanted me to have lunch with him. I sailed aboard his ships back in 1936, when they ran from New York to Antwerp and Rotterdam. So it was good to see Carl Frick again after all these years and bend the elbow together.

We sat down in the third-floor bar of the Downtown Athletic Club, which is really downtown, near the tip of Manhattan's Battery and right on the waterfront. We could see the big ocean liners go up and down the Hudson River almost under our windows.

But no sooner did we toast the good old days when I heard a familiar gravelly voice roar . . . "BILGEWATER!" Carl and I looked in the direction of that blast. Sure enough, it was Marmaduke Surfaceblow, leaning against the bar, with his right fist choking the neck of a bottle of Sandpaper Gin.

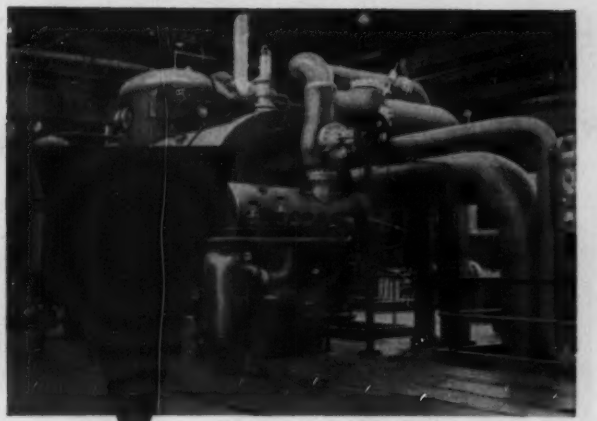
"I'll tell you broken-down rope heavers about the time I tamed Old Faithful at a girls' school and all I did was stop for lunch in their cafeteria," continued Marmy in his foghorn voice. He poured another shot and waited.

That did it. The bar was buzzing with shipping people but that blast quieted us all down. The cash customers were startled by this unusual interruption and looked questioningly at one another. Just as if he were at the Bent Propeller Bar, Marmy hooked his thumbs into the armpits of his checkered vest, turned his erect, 6-ft 4-in. frame toward his audience, then blasted away.

"Back in 1946 I was navigating along South St in New York City a few hours after being discharged from the Navy. Just as I passed Sloppy Louie's restaurant across from the Fulton Fish Market I ran into my old friend Jack Millar, president of the Millar Elevator Co. Jack and I were shipmates years before he started repairing and installing electronic elevators all over the country.

"'My boys are putting two automatics into the Grace Building on Hanover Square,' said Jack. 'I'm dropping anchor at Louie's here to stoke up on some littleneck clams and shrimp scampies. Be my guest for an hour or two and let's talk over old times.'

"After we'd stowed away a Martini and the clams, Jack told me something that made me heave to and take notice. One of his good friends was Geoffrey Nash,



# WHEN INDUSTRY NEEDS WATER

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## Marmaduke

Begins on page 166

administrator of Pickering College for Girls in Stony Brook, Long Island.

"Jack said his friend told him on his last visit that something embarrassing was happening at the school. For weeks the girls in Memorial Hall had been squawking that the toilets were 'exploding.'

"'Exploding?' I echoed, wondering if my ears were playing tricks. "'Yes, exploding,' Jack assured me. 'So the Physical Plant Dept sent a plumber to Memorial Hall on the double. He checked all the toilets, but they were OK.'

"'Just as I thought,' reported the plumber disgustedly, 'those wise-aleck gals are pulling our leg.' But before long more complaints came in. So again a check was made; again nothing was found wrong.

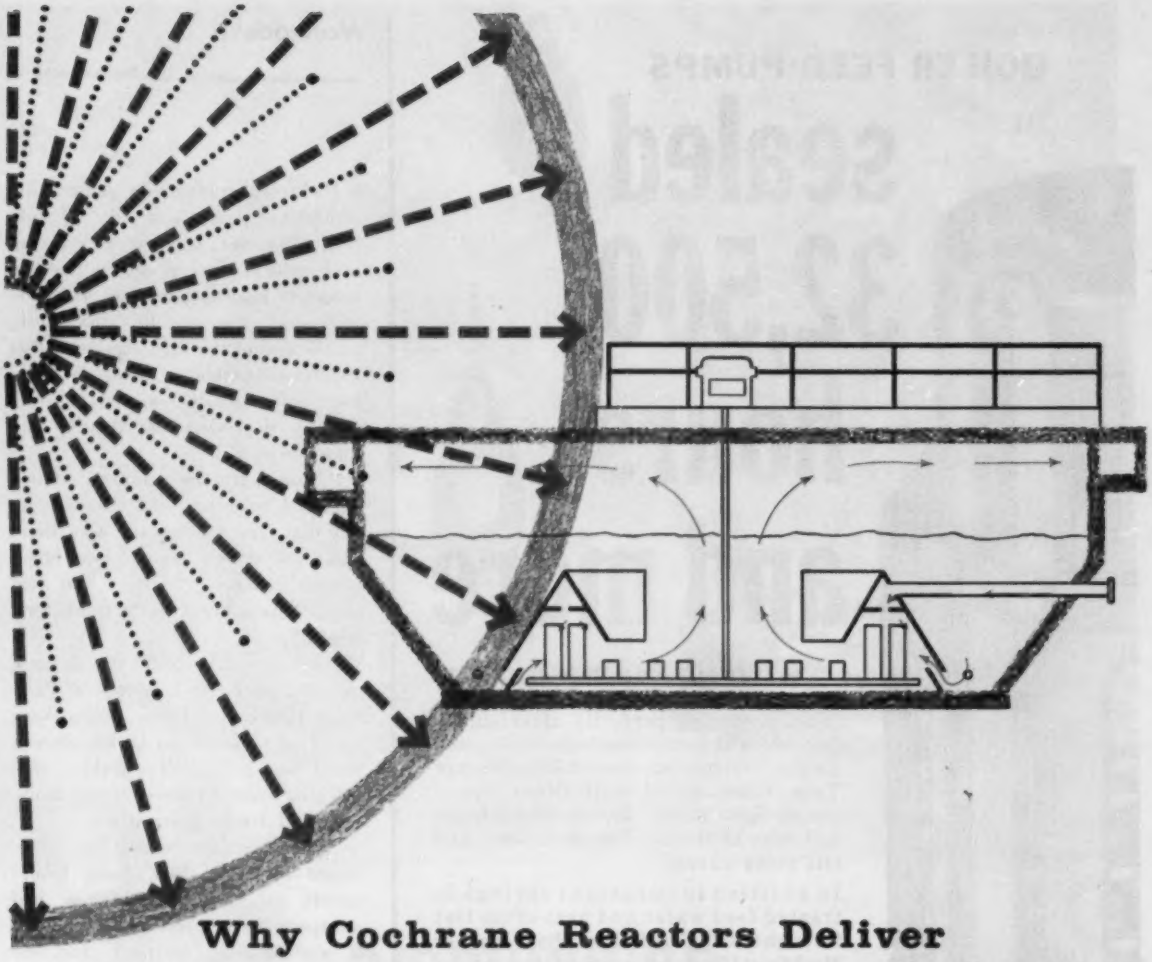
"Just about the time things quieted down and the girls had nothing more serious to be excited about than their next week-end dates, it happened again. This time Nash started plotting the complaints. Who made them? How often? When? Where? Was each complaint the same?

"In a few months a picture emerged. The squawks always came in on Monday morning. The time was always very early. The culprit was always the same washroom, and always the same fixture.

"Nash decided to do some first-hand sleuthing. He had four men from the Physical Plant Dept sent to the washroom early the next Monday morning. Then he selected one man who had heard nothing of the problem and asked him to flush the toilet. The unsuspecting handy man leaned over to depress the flushometer handle. FLOOIE!

"The contents of the bowl shot up like Old Faithful and drenched not only the handy man but the entire inspection party. Nash was convinced; so were the maintenance men who thought they had been making wild-goose chases. No wonder the young ladies complained. But at least the water was clean when Mr Nash made his formal test.

"Now the big problem was finding the cause. You didn't have to be



# Why Cochrane Reactors Deliver Better Water at Lowest Chemical Cost

Advanced design creates two zones within a single reactor "package":

1. *Reaction Zone* with ideal environment where old slurry is suspended to mix with new chemicals and incoming raw water.
2. *Clarifying Zone* in which solids settle out most completely as water flows radially and horizontally, rather than upflow, with decreasing velocity toward the periphery of the reactor to produce the clearest water without carryover of slurry.

Since each phase of the solids-contact process takes place under the most favorable conditions, chemical costs are kept at rock bottom, effluent is of highest quality.

For more details of Cochrane's exclusive design feature, send for the new Publication 5001-C, "Solids-Contact Reactors". In water softening and coagulating, as in other water conditioning methods, no one has more experience than Cochrane.

Representatives in thirty-six principal cities in U.S., also Havana, Cuba; Paris, France; La Spezia, Italy; Mexico City, Mexico; Caracas, Venezuela; Santiago, Chile; Manila, Philippine Islands.

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BOILER FEED PUMPS

# sealed 32,500 hours and more

***with no maintenance!***

"Still operating perfectly after almost four years of continuous boiler feed pump service," reports one user of Borg-Warner Type D Mechanical Seals. Other typical reports show 10,000—25,000—30,000 hours and more of trouble-free operation...and still going strong!

In addition to important savings in treated feed water and heat often lost through stuffingbox leakage, Borg-Warner Mechanical Seals have proved they can cut expensive down time and maintenance.

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If your present sealing method is not giving the long, reliable performance you think it should, we invite you to compare your record with actual user reports of B-W Type D Seals. Your nearest Borg-Warner Mechanical Seal sales engineer will be glad to show you the proof! Already sold? Then write or call for the new Type D Seal bulletin with complete engineering and installation data for equipping your present boiler feed pumps with modern Borg-Warner Mechanical Seals!

**BORG-WARNER®**
**MECHANICAL SEALS**
P.O. Box 2017A Terminal Annex
Los Angeles 54, California


## Marmaduke

Begins on page 166

a Pickering graduate to deduct that something gassy was feeding into the flushometer. And even a Pickering undergraduate could deduct that the pressure always built up over the week end. Also that this one fixture on the end of the line—and only this fixture—responded so violently when the first Monday-morning caller sleepily depressed the handle and asked for action.

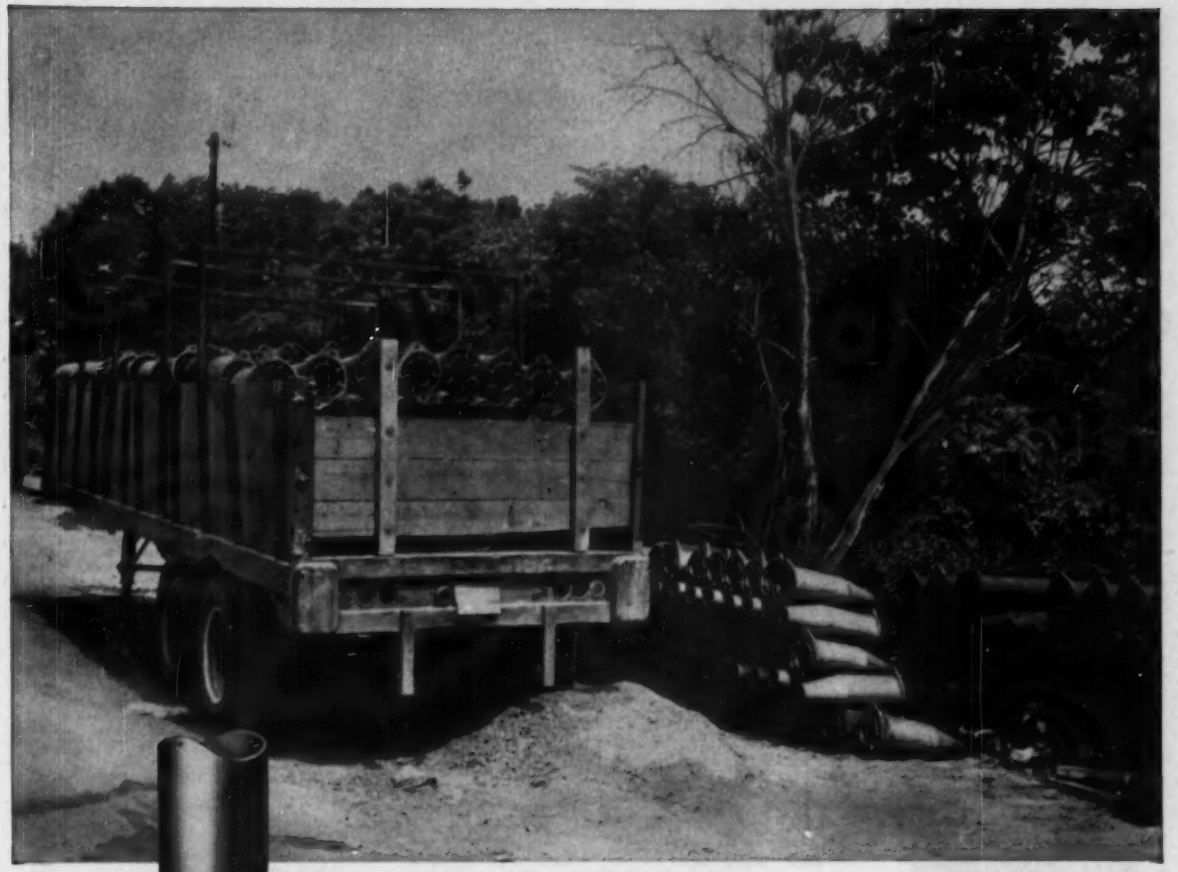
" 'And that's the problem,' smiled Jack. 'A belching toilet. I'm driving out that way tomorrow. Why don't you come along? We can have lunch in the college cafeteria. You just might have a brain storm to help my friend.'

" 'It's a deal,' I said. And the next morning Jack and I arrived at Pickering College for Girls. When Nash asked us to sit down in his office I could see he didn't consider that belching toilet a joke—not any more. Jack and I soon learned why.

"Just three days before, Mrs. Stuyvesant McHenry Bell, Long Island society gal and philanthropist, had unexpectedly dropped into the school. It was Monday morning, and she was on an inspection tour of several girls' schools on the Island. It was rumored that she was drawing up her will and would leave over two million dollars to a few schools. But she wanted to see each one in operation — talk with the girls, get some firsthand, off-the-cuff information about each seat of learning. That was the reason for this unannounced early-morning call.

"It was eight am when Mrs Bell got out of her Rolls and barged into Memorial Hall where she ran into the dean, Miss Priscilla Forsyth. All the gals in that sorority house had learned the hard way about Old Faithful, so they gave it a wide and respectful berth. But of course Mrs Bell didn't know, as she suddenly excused herself from Miss Forsyth and dashed into the john.

"Miss Forsyth was flustered at running so unexpectedly into this distinguished guest, but had the presence of mind to ask two girls headed for the washroom to stay out because Mrs. Stuyvesant McHenry Bell was



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C10
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Fighting dust is the purpose of this load of Cyclo-trell C10 "shells." ■ Cyclo-trell units for process gas or air cleaning in steel mills, refineries, paper, cement or chemical plants give you high efficiencies. ■ Engineered to fit each specific job, Cyclo-trell units are available in a wide range of sizes and types including C10, C24, IC (Involute Cyclo-trell) and ICL (Involute Cyclo-trell, Lined). ■ Why not let us consult with you on your specific dust collection problems? For further information, write for Bulletin 300 which describes several applications in detail.

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For more facts circle 298 on Reader Service card, p 103

INSIDE STORY — HEV-E-OIL burner is the *only* commercial-industrial burner that successfully applies the principle of low-pressure air atomization of heavy fuels *inside the nozzle.*

# HEV-E-OIL BURNERS

HEV-E-OIL commercial-industrial burners operate on the principle of low-pressure air atomization and furnish *all the air necessary for complete combustion.* This assures efficient, economical operation — perfect fire control regardless of weather or draft conditions. And HEV-E-OIL burners offer you *double savings!* They are especially engineered to make use of inexpensive heavy oils — number 4 and 5. Number 6 or Bunker C in larger models. Available from 5 to 150 gph.

**HEV-E-DUTY POWER GAS BURNERS** meter air in perfect proportion to the amount of gas used — high efficiency regardless of uncertain stack draft. HEV-E-DUTY COMBINATION GAS & OIL BURNERS offer fuel-proof changeover from gas to oil — in most models just a flip of a switch makes the change. Capacities from 720,000 to 21,000,000 Btu.

These fine burners offer many other sure-fire features! Complete package! Low-fire start! Fire tested! Completely automatic! Meet all codes! Safe, electronic controls! Simple installation! Send for free bulletin. Write Industrial Combustion, Inc., 4507 N. Oakland Ave., Dept. P-60, Milwaukee 11, Wis.

**INDUSTRIAL COMBUSTION INC.**

EXECUTIVE OFFICES: 4507 N. OAKLAND AVE., MILWAUKEE 11, WIS.


## Marmaduke

Begins on page 166

inside. The girls looked at each other and busted out laughing.

" 'Girls, girls,' reprimanded Miss Forsyth, very much alarmed, 'please try to be sophisticated!' But that's as far as she got. A loud bloodcurdling shriek like someone being harpooned came from the washroom. The door busted open and out flew Mrs. Bell, screaming very unladylike, 'Why, I never . . . good heavens . . . ohhh!' She looked like she had been keelhauled, to put it mildly.

" 'Sounds pretty frightful, doesn't it?' asked Mr Nash, looking sadly at Jack and myself. 'And to think that damn flushometer probably cost us a half-million-dollars endowment.' He mopped his wrinkled forehead and looked sickly out the window towards Memorial Hall. It was a memory all right, but not a happy one.

" 'Well, enough of this; it's lunch time, gentlemen,' said Nash suddenly. 'Let's go to the cafeteria.' That suited Jack and myself just fine, but that story about the belching toilet in Memorial Hall had me guessing.

"After dessert and a smoke the three of us were leaving when I noticed a Coke machine near the door. I stopped and looked at it. 'Oh, yes,' said Nash, seeing my interest, 'that machine was installed a few months ago. We try to make life convenient for our girls.'

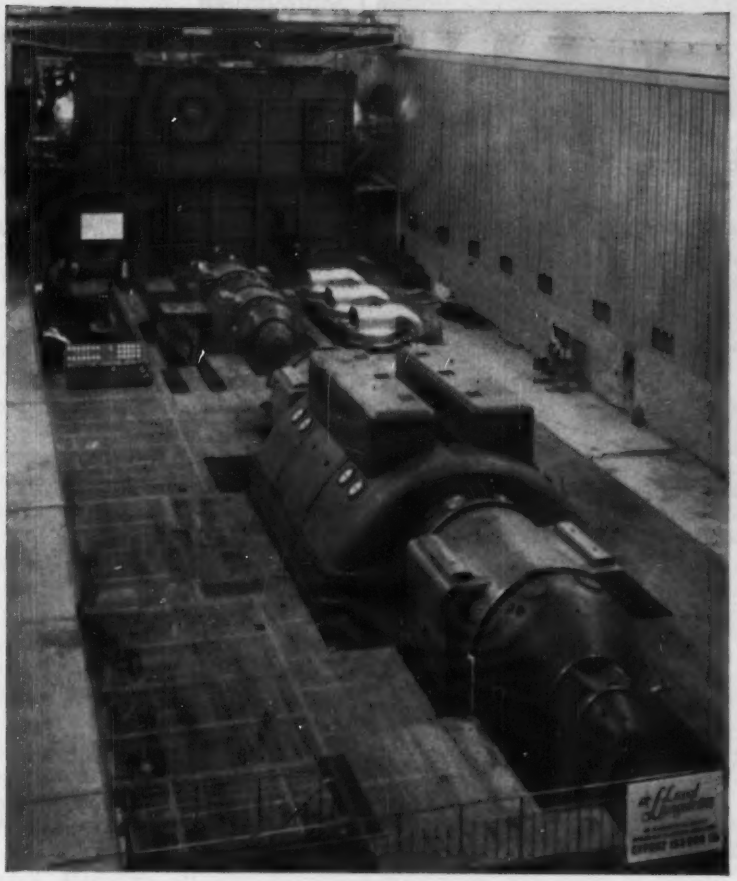
" 'Would you mind letting me see the piping blueprints?' I asked him. 'I've got a hunch, nothing more, just a hunch.' The three of us hotfooted over to the Physical Plant Dept office. But I didn't find what I was looking for on the blueprint.

" 'Sorry,' I said to Nash, 'but I don't see what I want. Maybe you can tell me who's responsible for that Coke machine being installed.'

" 'Why, the plant superintendent, I guess,' said Nash. 'Want to talk with him?'

" 'Yes,' I said, hoping my hunch was right. Just then the Plant Superintendent walked in. No, he didn't know anything about the Coke machine being installed until after it was in, when he returned from his vacation. But maybe the cafeteria manager knew. Back we barged to the cafeteria.

continued



*160 MW re-superheated steam turbine at Stenungsund, Sweden*

# Base Load and Peak Load Machine in One and the Same Set

Base load machines are built to go as light on fuel as possible, at the same time generating a given number of kilowatt hours. This object is achieved by high efficiency machinery, operating at maximum load where the best utilization of the fuel is attained. A second advantage of such top efficiency equipment is that extra kilowatts are obtained, representing a free of charge capital cost of the same order per kilowatt as that spent on the station as a whole.

Peak load sets should allow for quick and simple starting in order to keep fuel losses during starting-up periods at a minimum. Thereby, they also provide stand-by power in case of line trouble.

The latest Scandinavian steam power station in Sweden employs two 160 MW turbines which combine both these qualities. The net over-all efficiency of the station, including boilers and auxiliaries, is about 39% (turbine efficiency 7785 BTU/kWh). Still, the turbines may be started and synchronized in five minutes from cold. Load may, thereafter, be applied as fast as steam is generated.

Outstanding running experience has been obtained with the first turbine set, which was commissioned in November 1959. In addition, two 320 MW sets are now being designed.

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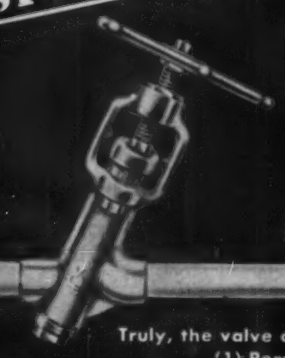
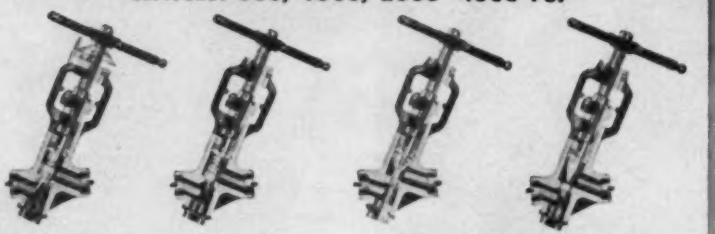
SPECIFY: VELAN
FORGED STEEL BONNETLESS VALVES
For High Pressure/Temperature Service

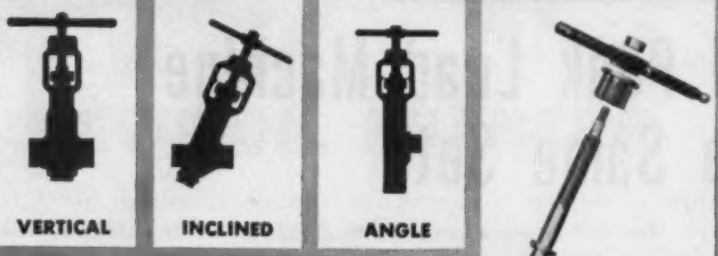


Truly, the valve of the future—the only one combining:
(1) Permanent tightness of the seat joint
(2) No bonnet-body joint and
(3) In-Line servicing without removing welded joints

CLASSES: 600, 1500, 2500 4500 PSI

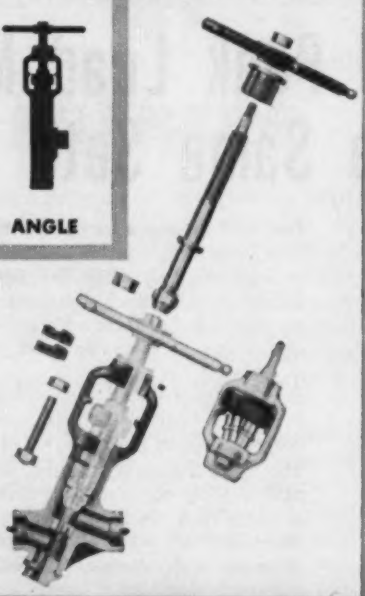


TYPES: STOP | STOP-CHECK | NEEDLE | FLOW CONTROL



VERTICAL | INCLINED | ANGLE

ONLY 3 MINUTES
to disassemble in-line



SAVE:

In initial cost 25%
In Maintenance 50%

PRODUCTS OF VELAN'S *Creative Engineering*
FOR POWER PLANTS
*Write to Velan Companies in:*
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## Marmaduke

Begins on page 166

"'Sure, the man who delivered the Coke machine installed it,' said the manager. 'There was nothing to it; all he had to do was run copper tubing to the basement.'

"'Take us to the basement and show us where,' I asked, feeling I was hot on the trail of something.

"'Oh, I don't know where,' said the manager good-naturedly, 'I didn't have time to watch him. He seemed to know what he was doing.'

"The four of us went below to the basement, and there I struck gold. The 3/8-in. water line for the Coke machine was tapped into the fresh-water system, which was OK. But no one had bothered to sketch it onto the piping diagram.

"'Here's my theory,' I told my audience. 'The Coke machine takes water from the system through this copper tubing and mixes it with carbonic gas and Coke syrup, which is measured out into paper cups when a coin is inserted. It must have a pressure regulator for the carbonated water.

"'Evidently the regulator leaks very slightly. So the carbonic gas, at a higher pressure than the water, leaks slowly back into the water. Over the week end the carbonic-gas pressure has time to build up gradually in the fresh-water line. It travels to the end of the line, which is slightly upgrade and right under the belching toilet in Memorial Hall.

"'By the time that toilet is flushed first thing Monday morning, there's enough carbonic gas to explode into the bowl. Only enough accumulates over the week end for that one blast!'

"Well, a plumber was asked to dismantle the pressure regulator. It was leaking, all right. For good measure, I suggested they put a check valve into the copper line.

"'But what made you suspect the Coke machine?' asked Nash, after the problem was solved.

"'Only one thing could cause the water in the bowl to erupt so violently,' I told him, 'and that was compressed air or some other gas. But I could see no air or gas used anywhere until I noticed that Coke machine. Then I remembered seeing a serviceman replace an empty car-

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GREATER OZONE RESISTANCE · SUPERIOR
DIELECTRIC PROTECTION · LONGER LIFE · LOWER COSTS ON THE JOB
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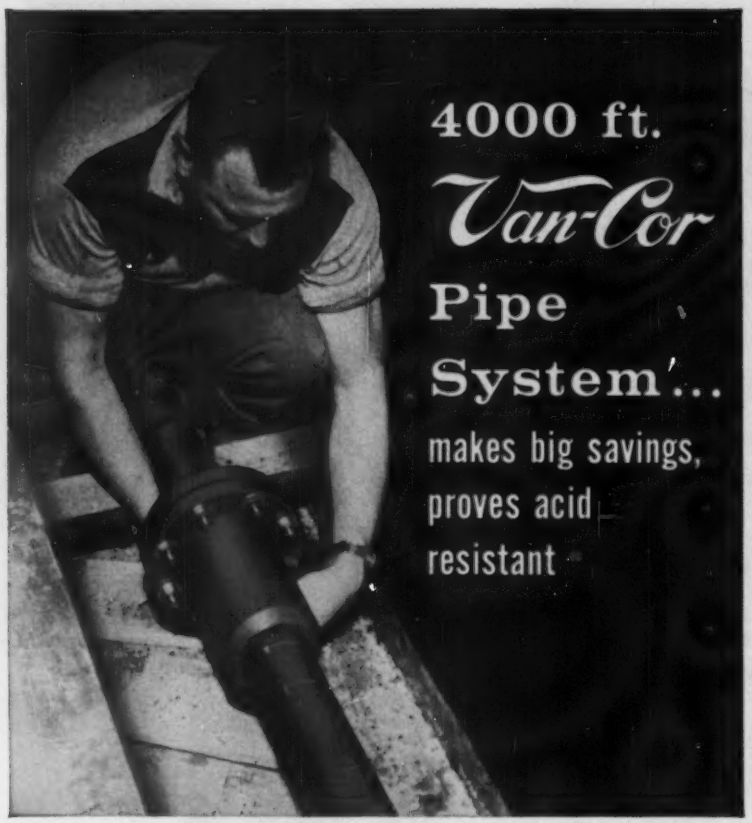
For more facts circle 302 on Reader Service card, p 103



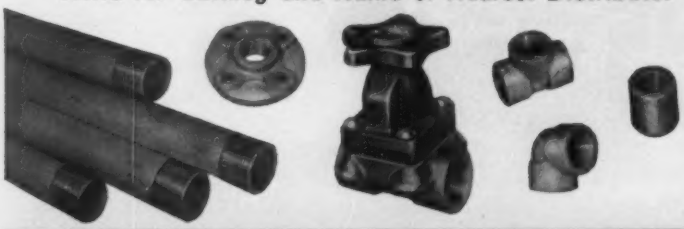

At the Allentown (Pa.) Works of the Western Electric Co., the entire waste acid disposal system in the recent addition consists of Van-Cor rigid PVC pipe and fittings.

**HOW COSTS WERE CUT.** Initial price of Van-Cor was ⅓ that of comparable cast iron alloy pipe. On a 6" line, labor costs were estimated at 29¢ per foot of run—about half that of metallic pipe. Also, because Van-Cor has only 1/10 the weight, no mechanized handling equipment was needed. Available in 10 or 20 ft. lengths, Van-Cor requires fewer joints, and eliminates the breakage problem.

**CORROSION LICKED.** Van-Cor pipe was used because "corrosion resistant" cast metallic pipe had performed short of expectations in an adjacent building. After 1½ years service, the Van-Cor system is in excellent shape, unaffected by such acids as hydrofluoric, hydrochloric, sulphuric, nitric and many plating solutions.

Investigate Van-Cor Pipe, Fittings, Valves, Electrical Conduit, and Fabrications . . .

*Write for Catalog and Name of Nearest Distributor*



INDUSTRIAL DIVISION OF
**COLONIAL PLASTICS MFG. CO.**
Subsidiary of THE VAN DORN IRON WORKS CO.
2685 EAST 79TH STREET CLEVELAND 4, OHIO


## Marmaduke

Begins on page 166

bonic-gas cylinder with a full one in a subway-station machine.'

"The last time I heard from Jack Millar he told me all was again quiet at Memorial Hall," wound up Marmy, turning back to the bar, "but Old Faithful wasn't forgotten at Pickering College for Girls, not by a long shot."—STEVE ELONKA

---

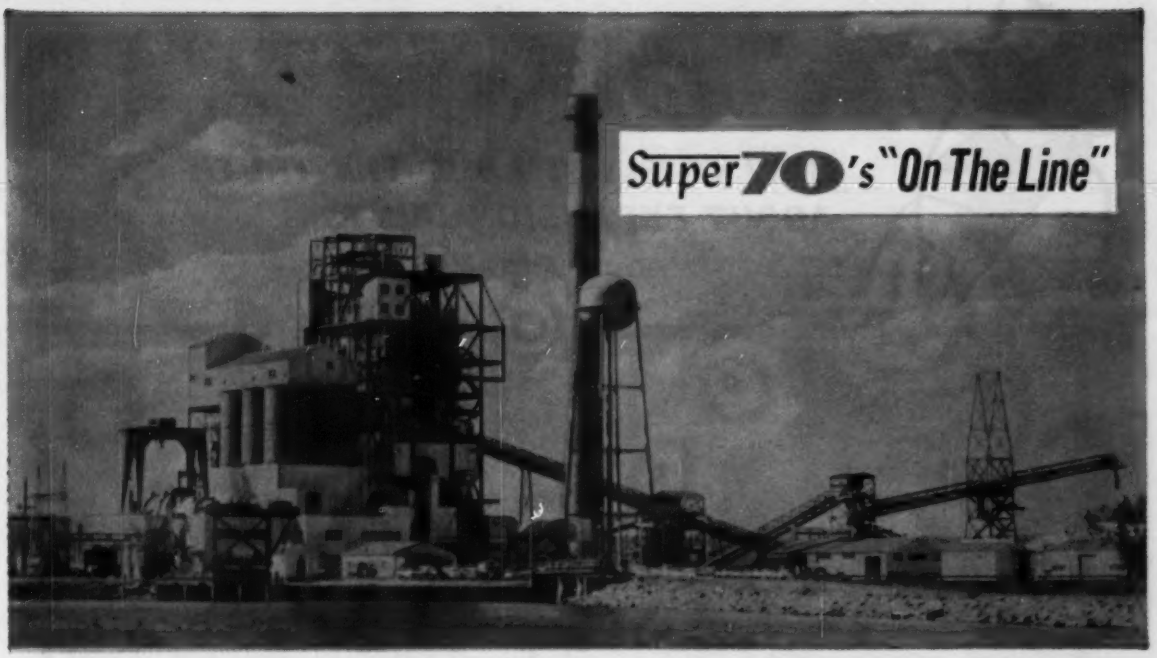
**Marmy's mailbox**

MARMY SEEING DOUBLE?

I enjoyed *Marmy goes to the dogs* in Dec 1959, but take issue with him on the *SS Robert Dollar*. That ship was only a gleam in a Clyde shipbuilder's eye in 1912. About 1914, she was in coal ballast from Clyde to San Francisco via the Panama Canal when war broke out. Culebra Cut in the Canal was holding up passage so she was in port on the east coast of South America awaiting orders whether to proceed by the Strait of Magellan or wait for Culebra Cut to be cleared. Incidentally, in a phony deal with a German consul, a rendezvous was arranged for transfer of her coal ballast to a German cruiser somewhere en route to Magellan. A British consul had information that the Canal would be passable. Well, she sailed north instead of south and was one of the first ships to pass through the Canal.

Marmy must have been seeing double after twin shots of Sandpaper Gin at the Bent Propeller Bar. The *Robert Dollar* was a single-screw vessel rather than twin. I can vouch for this, having sailed as chief on two of her sister ships. Tell Marmy I still think his stories are great, but let's keep the records straight on the good ship *Robert Dollar*, or Davy Jones may question us.

P S RENNIE, *Los Angeles, Calif.*



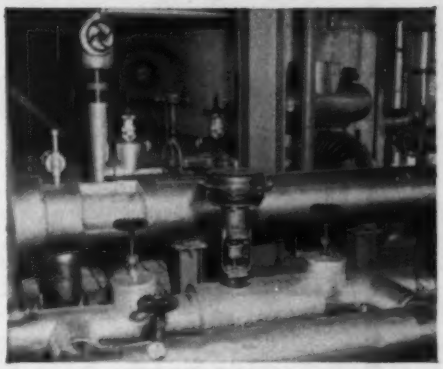

# New Pioneer Along The "Old Oregon Trail"

Within sight of the "Old Oregon Trail" near the town of Glenrock, Wyoming, rises a new monument to Wyoming's modern era of industry and progress. It is Pacific Power & Light's new $23-million Dave Johnston steam-electric plant which boosted Wyoming's total electric power supply by one-third.

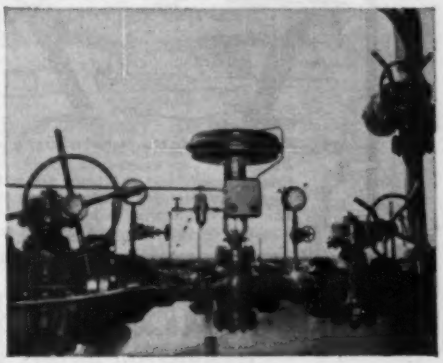
Engineered and constructed by Ebasco Services Incorporated, this ultra-modern plant utilizes BS&B Super 70 Diaphragm Control Valves, Pressure Controllers, Liquid Level Controllers and Transmitters for many vital roles in the plant's operation.

In the forthcoming No. 2 Unit of this plant, BS&B Controls will again render proud service to the Power Industry.

BS&B Controls are becoming renowned throughout the power industry for their superior performance characteristics and rugged dependability under widely varying operating conditions. Why not specify them for *your* next plant project? For detailed information, contact your nearby BS&B Controls Representative, or write directly to...



Evaporator Feedwater Level Control Valve



Plant gas supply is reduced from 400 to 150 psig by this Super 70 Pressure Reducing Valve and Controller.

BS&B — ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

**BLACK, SIVALLS & BRYSON, INC.**

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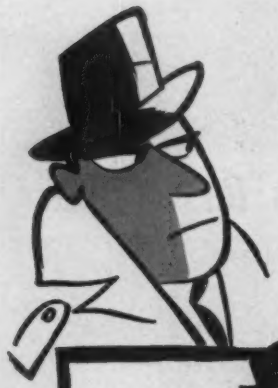
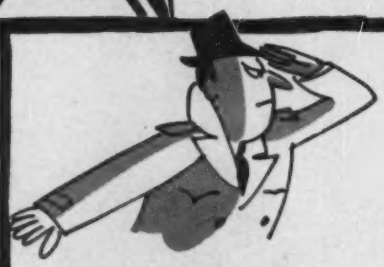
For more facts circle 304 on Reader Service card, p 103



# HOW TO SLEUTH OUT THE TRUTH ABOUT EXPANSION JOINTS



**1** **Case the joint (design, that is)**

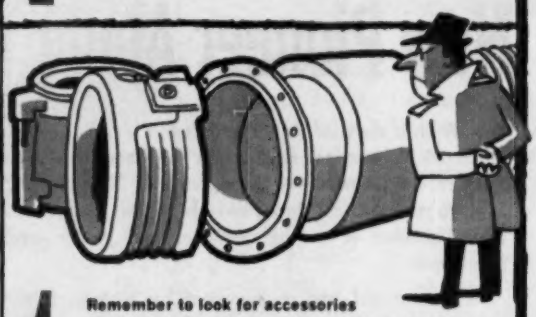
Badger S-R Expansion Joints have: 1. Corrugations which assume "all curve" shape under pressure — low stress, long life. 2. Tubular rings allow flexing over more of corrugation height.

**2** **"Weigh" the evidence**

S-R Joints have no bulky castings . . . weigh up to 50% less . . . diameter equivalent to pipe flange. Installation is easier, lighter supports required.

**3** **Search for clues in fabrication methods**

Bellows are hydraulically formed to produce uniform corrugations with minimum thinning of material. Quality controlled longitudinal welding, no multiple circumferential welds.



**4** **Remember to look for accessories**

Full line of accessories — including covers and liners. Easy to pick proper combination of model, type and accessories for any pressure, temperature, erosive or corrosive condition.

**5** **Pull an M.O. on the manufacturer's background**

Badger's 50-year experience includes development of first successful self-equalizing design for higher pressures, temperatures. Badger has had more fabrication and engineering experience in more different applications than any other manufacturer.

**6** **Close the case — buzz Badger**

See the Badgerman for expert help on your most exacting pipe expansion problems. He knows his business, your problems. Call or write today.

**BADGER** *Expansion Joints* **S·R**

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*Still ANOTHER Cottrell Advancement By Western Precipitation...*

# UNIQUE "FULL-RANGE" RAPPER CONTROL PROVIDES ENTIRELY NEW STANDARDS OF VERSATILITY

*Rapping Frequency... Rapping Intensity... Rapping Pattern*

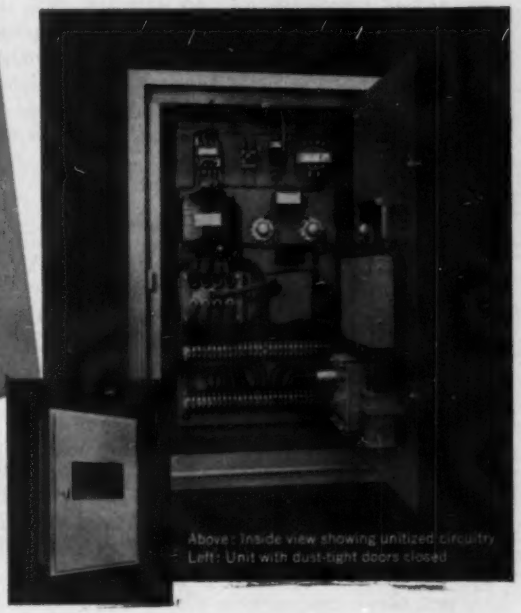
*ALL EASILY ADJUSTABLE TO MEET OPERATING REQUIREMENTS*

## THE PROBLEM:

In the operation of Cottrell Precipitators it is necessary to remove the dust, fume or fly ash that has collected on the plates and cause it to be deposited in a hopper for subsequent removal from the Precipitator. The Rapping System should accomplish this removal with minimum disturbance to the already collected material (to avoid re-entrainment) and with maximum cleaning of the plates.

However, collected materials vary widely in their physical characteristics. Some are sticky. Some agglomerate readily and in thick layers without disrupting electrical operation. Still others have no tendency whatever to agglomerate, but form a sheet of loose particles on the plate.

There is no "typical" dust—no fixed set of conditions to be met. Yet the Rapper System must be readily adaptable to efficient dust removal, regardless of dust characteristics!



Above: Inside view showing unitized circuitry
Left: Unit with dust-tight doors closed

## THE SOLUTION:

With so many variables to be compensated, unusually wide adjustability of the Rapper System has long been a prime objective for optimum operating efficiency. But complex factors have prevented its attainment until development of Western Precipitation's new "Full Range" Rapper Control.

By simply adjusting a few dials, "Full Range" Control permits:

- **FULL FREQUENCY ADJUSTMENT** from a complete rapping cycle every 50 seconds to one every 3½ hours... or any desired cycle in between!
- **FULL INTENSITY ADJUSTMENT** from zero to maximum over an unusually wide range!
- **FULL PATTERN ADJUSTMENT** 2, 4 or 8 impacts per cycle can be selected, with each cycle varying from light to heavy on successive impacts within the cycle—all automatically controlled to a choice of pre-selected operating limits!

## *Other Important Advantages...*

***Greater Safety:*** The "Full Range" Control has no dangerous high voltage circuits to endanger personnel. Entire unit is in "low-voltage" category.

***All "Passive" Design:*** There are no motors, gears, or other high maintenance components in the "Full Range" Control. It is completely electronic.

***Space-Saving Compactness:*** The "Full Range" Control requires about *half* the space of previous designs. Also is water and dust tight—can be located virtually anywhere.

***Unitized Circuitry:*** All related parts are unitized into separate "cans" for simplified maintenance.

*Free!* **NEW BROCHURE** which describes and illustrates the new "Full Range" Rapper Control—the latest product of Western Precipitation's program of continuous advancement!

*For quick assistance, call or wire collect our nearest office.*

WESTERN PRECIPITATION
DIVISION OF JOY MANUFACTURING COMPANY
1000 WEST 9TH STREET, LOS ANGELES 54, CALIFORNIA
NEW YORK 17 • CHICAGO 2 • PITTSBURGH 2 • ATLANTA 5 • SAN FRANCISCO 4
IN CANADA: 8562 MOUNTAIN SIGHTS AVENUE, MONTREAL, P. Q.

For more facts circle 306 on Reader Service card, p 103

# Powerscope . . . A selective look at

## National Science Foundation

The NSF began its tenth year on May 10, 1960. It was created when President Truman signed the National Science Foundation Act in 1950. After a small appropriation to get started in 1950, it received a grant of $3.5 million in 1951. Appropriation for fiscal 1960 is $152 million. The foundation largely supports basic research, mostly done in colleges and universities. It encourages and supports training in science for teachers, scholars and students.

## Bakeable valve

Many of the United Kingdom Atomic Energy Authority's labs have vacuum valves using expendable metal or nonmetallic seals. These have very short lives. Now their engineers have developed a new metal seal. A deformable metal valve seat forms a seal by plastic flow, through pressure from a flange on the nose portion of the valve. When the nose portion is withdrawn, its flange forces the washer to a position similar to original position in the valve seat. Baking the entire valve, without removing it, anneals a workhardened washer to extend its useful life. These deformable washers may be made of gold, platinum, palladium, copper, aluminum or ductile alloys. Valve spindle and body are made of stainless steel.

**Paradise Steam Plant of the TVA in western Kentucky will have two General Electric steam turbines, each rated 650 mw. Babcock and Wilcox Co will build the boilers. First unit will start running in 1962, second is slated for startup in fall of 1963.**

## Steam drills water wells

U.S. Army uses steam to drill water wells at its Camp Century on the Greenland icecap. These wells supply water for 200 soldiers and scientists living in the camp this coming winter. A Vapor Heating Corporation steam generator supplies steam at 175 psig; steam drills a 40-in. dia shaft about 150-ft deep. At depth the steam melts out a 50-ft-dia bell-shaped reservoir that holds the water supply. As water level drops, steam bit drills deeper into the icecap, down as far as 600 ft. Empty wells could be used to store gasoline, machinery, food for possible war needs.

**General Electric Company is developing a fuel-cell power source for the U.S. Marine Corps, Army Signal Corps and Navy Bureau of Ships. Units can generate 200 w of 24-v dc for 14 hr. The 30-lb pack can be carried by one man and will replace a 55-lb generator or 80 lb of secondary batteries. Pack can generate full power for a week on 72 lb of fuel. Units have 30 ion-membrane fuel cells, each 11-in. square and about ¼-in. thick. Fuel is oxygen from the air and hydrogen from decomposing a metal hydride. Cells are odorless, run at negligible pressure and temperature and use a solid electrolyte.**

## 9200 eyes

The U.S. Tiros weather-eye satellite uses 9200 silicon solar cells for its primary power source—an application of solar cells to power miniaturized television equipment. Tiros was designed and built by RCA's Astro-Electronic Products Div for the National Aeronautics and Space Administration. Cell array has a peak output of 58 w at 28 and 14 v. The satellite uses nickel-cadmium batteries to store energy for peak demands and when in the earth's shadow. Each cell measures 1x2 cm and has a special optical coverglass to protect it from micrometeorite abrasion and hold down cell temperature by raising thermal emissivity.

## Which cooling system?

**A broad research program started by Battelle Memorial Institute for the Air Force will seek cooling systems to improve overall effectiveness of ground-based electronic equipment. They will study high-speed centrifugal compressors, Peltier cooling units, Stirling and azeotropic cycles; also will dream up new cooling techniques. Specialists in refrigeration, combustion, thermo and fluid dynamics, heat transfer, physical chemistry, solid-state physics, organic chemistry and electronics will work on the project. Manufacturers and research groups will be enlisted as needed.**

## Gas on tap

Pacific Gas and Electric Company has placed its first natural-gas storage field in operation. A 240-hp compressor injects the gas into the 400-acre Pleasant Creek Storage Field, northwest of Winters, Calif. Compressor forces gas into the partly depleted gas field through two well pipes about ½-mile deep. Part of the injected gas will remain as a permanent "cushion" to prevent water from intruding and damaging minute cells in the porous earth layers. At full capacity pressure will reach 1250 psig. Initial field capacity will be 1.2-billion cu ft and ulti-

# this month's power-field happenings

By B G A SKROTZKI, Associate Editor

mately will rise to 3.25-billion cu ft. At ultimate development, as much as 80-million cu ft per day will be withdrawn for peaking operation.

## Water handling

**Allis-Chalmers is building the largest plate-steel spiral case in the free world. Measuring 27½-ft dia at inlet, the casing will distribute water to one of three hydro turbines for TVA's Wilson Dam in Alabama. Each of the three turbines when running under 86-ft head at 106 rpm will develop 74,600 hp. Volume of water flowing through one unit equals about 80% of the water flowing over the American Falls at Niagara.**

## More awards

Appalachian Power Co and American Electric Power Co awarded six contracts for their Smith Mountain Dam project, nation's largest river-flow and pumped-storage plant. General construction went to Sollitt Construction Company of South Bend, Ind.; four turbines to Baldwin-Lima-Hamilton Corporation; two reversible pump turbines and two motor-generators to Allis-Chalmers Mfg Co; two generators and nine air circuit breakers to General Electric Co; two generators to Carrier Corporation's Elliott Div; six transformers to Westinghouse Electric Corporation. Estimated total cost is $50 million.

**The 27th Semi-Annual Electric Power Survey of the Edison Electric Institute found that 42-million kw of new capacity is scheduled for installation. Over 90% of this will be installed by the end of 1963. Addition of 12-million kw during 1960 will bring national capability to 170.5-million kw by year end. Energy output for 1960 is expected to reach 770-billion kwhr. The trillion-kwhr-output mark will be reached in 1963; corresponding installed capacity will be 203-million kw.**

## High-speed gas turbines

AiResearch Manufacturing Div of The Garrett Corporation has built a 30-hp gas turbine driving a 7.5-kw direct-mounted generator and running at 3200 cycles. Static silicon-controlled rectifiers convert the output to 60 or 400 cycles. Next to be built is a 100-kw turbine-driven generator, now under development. This one will weigh about 800 lb, compared to 5800 lb for lightweight engine-driven generators of equal output.

## Hydro turbines by American builder

Baldwin-Lima-Hamilton Corporation won a $6.4-million contract to supply eight hydro turbines to the U.S. Reclamation Bureau's Glen Canyon Dam power plant in Arizona. About 42.7% of the total amount represents parts to be made in Belgium. This bid won out over an English Electric Company bid of $6.2 million. After evaluation to include services of an erecting engineer and the 6% differential under the Buy American Act, EEC bid ranked as second lowest.

## Gate-level controller

**T Urban of Linz, Austria has patented a control method that measures the exact position of a sluice gate's upper and lower edges on both sides. When movement of the gate reaches a certain differential of the two sides, gate is automatically stopped just prior to jamming. Plant operator then must investigate to rectify gate trouble and complete the operation.**

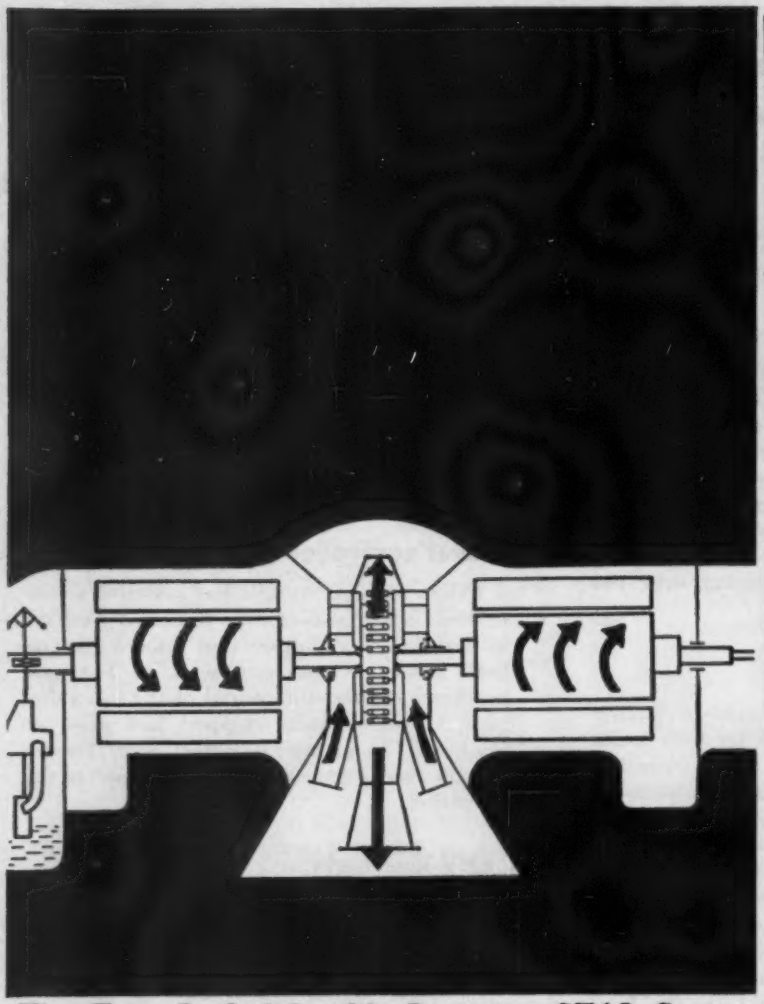
## New EHV-line tests

American Electric Power Service Corp and Westinghouse Electric Corp will build a 750-kv experimental transmission line along the Ohio River at Apple Grove in W. Va. Line will use about 130,000 ft of ACSR cable—aluminum cable reinforced with steel messenger cable—made by Kaiser Aluminum and Chemical Corporation. Other participating companies include: Lapp Insulator Co, Inc; Ohio Brass Co; Thomas and Betts Co, Inc; American Bridge Div of U.S. Steel Corp. Three sections of the EHV line will be strung so different kinds of conductors can be tested simultaneously in the same environment.

## Why automation?

**According to E I Maher of National Association of Manufacturers, in early 1800's we had three farmers for every other worker in the U.S. Today, automation allows each farmer to feed his own family and nine others besides. The U.S. today burns up 13 times as much motor fuel as it did in 1920, but oil-industry employment has only increased 1.74 times. Today we have four times the number of telephones we did in 1920, but phone employment has risen only 1.3 times. Overall, automation increases job opportunities and raises our national standard of living tremendously.**

continued



# The First Radial Double Rotation STAL Steam Turbine In The United States

The last word in thermodynamic efficiency, lowest space requirements, inexpensive foundations, and low crane costs is Sweden's Radial Double Rotation STAL Steam Turbine. Designed to meet the most demanding requirements, STAL Steam Turbines are installed in power stations the world over with unparalled success. The ease of handling and simplicity of operation will make the Radial Double Rotation Turbine a favorite with power stations, paper mills, chemical plants and hundreds of other users in industry here. For free illustrated booklet and list of the major installations write to: ASEA ELECTRIC, INC. 500 Fifth Ave., New York 36, N. Y./55 New Montgomery St., San Francisco, Cal.

*U.S. Representatives DeLaval-Ljungström Turbine Co.*

ASEA

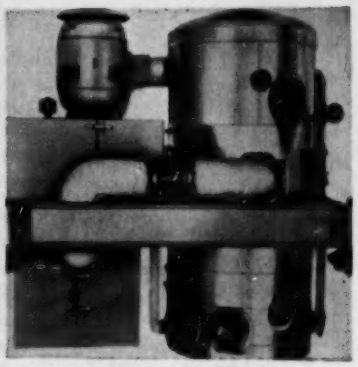
STAL 5 23,600 kva turbo-generator at Detroit Edison's Beacon Street Heating Plant

**Specifications**

| | |
|---|---|
| Make | STAL |
| Type | Radial flow double rotation |
| Throttle Steam Conditions | 870 psig, 700F |
| Maximum Throttle Flow | 500,000 lbs/hr. |
| Heaviest Life During Erection | 21.5 tons |
| Turbine Heat Rate | 3506 Btu/kwhr |
| 2-3600 rpm Generators | Air Cooled |
| Power Factor | 0.85 |
| Back Pressure | 150 psig |
| Rating | 23,600 kva (combined) |


## Powerscope

Begins on page 180



### Vapor compression distills fresh water for U.S. subs

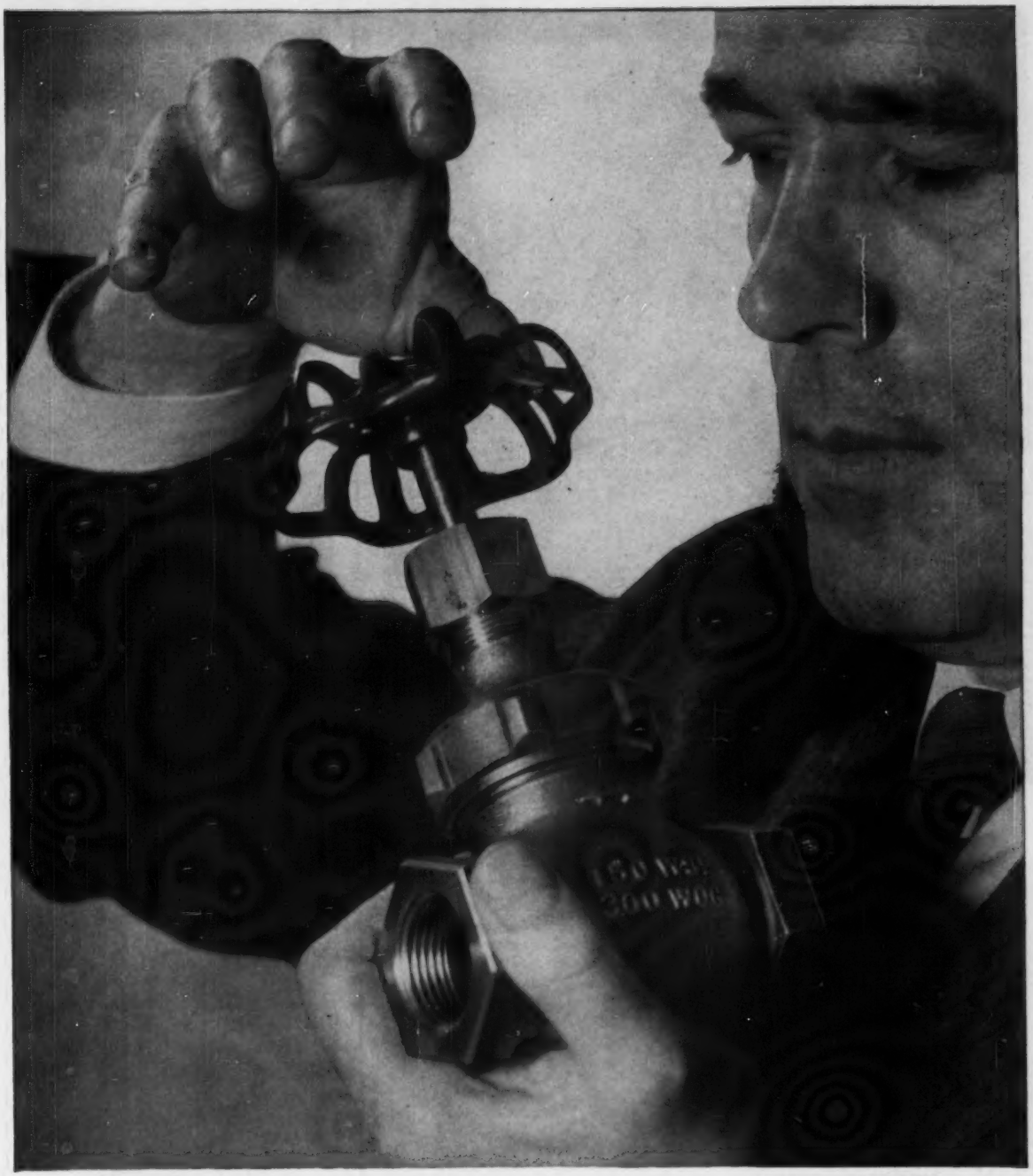
A vapor-compression still producing one gal of fresh water from each 1.5 gal of sea-water feed will be used aboard the Navy's newest submarines. First production model, a 2000-gpd unit made by Badger Manufacturing Company, has already been delivered to Portsmouth (N.H.) Naval Shipyard for crafts in the Polaris Submarine Program.

Still will operate with sea-water temperatures as low as 28 F. Sound and vibration levels, important factors in guarding against underwater detection, have been greatly reduced by center-of-gravity mounting on a shockproof mount designed and developed by the Engineering Experimental Station, Annapolis, Md. This mount, coupled with use of rugged materials (generally 70-30 cupronickel) is expected to give exceptional shock-resistant characteristics.

### Gas turbine powers truck for hauling ore

First subjection of an automotive gas-turbine engine to the rugged requirements of ore hauling took place in Copper Cliff, Ont. A 225-hp gas-turbine engine manufactured by the Allison Div of General Motors Corp was installed in a truck used for hauling ore at The International Nickel Company of Canada, Ltd open-pit mine in Ontario's Sudbury District.

The multifuel engine is said to produce over twice the power of a com-



**MEN WHO OPERATE VALVES** like the *sure grip* they get on an O-B handwheel—find it's contoured to fingers, safely non-heating and won't slip under wet or greasy grasp! Just one of many advance-planned features you get by standardizing on the complete O-B bronze valve line. Ask your distributor for the valve in the orange-and-black box.

OHIO BRASS COMPANY • Mansfield, Ohio

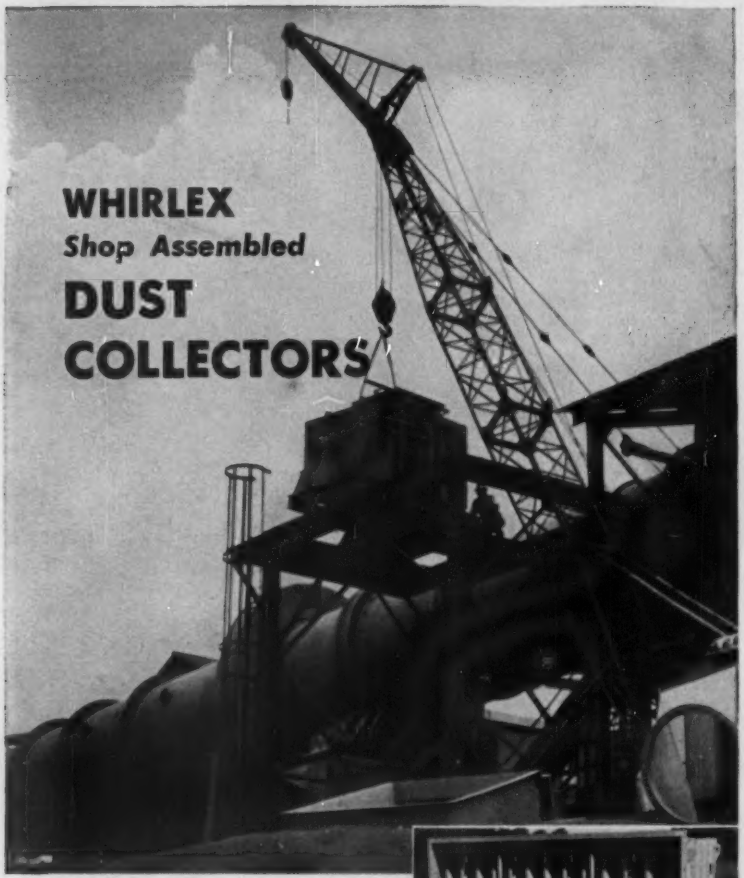
**O-B VALVES**

HOLAN

10073-V



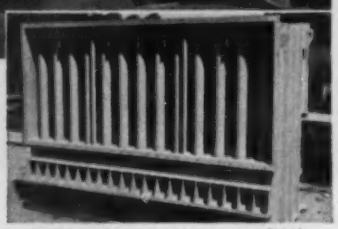
For more facts circle 308 on Reader Service card, p 103



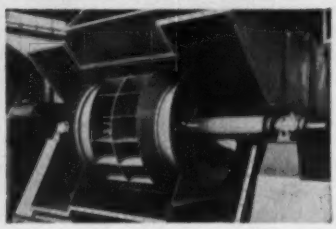

**. . . Cut Erection Costs to a Minimum**

This highly efficient Whirlex collector is completely shop assembled and need only be bolted in place at the erection site. Rigid shop inspection assures a "gas-tight" installation thus eliminating the opportunity of error at the job site.

*A Whirlex Shop-Assembled Dust Collector may be the answer to your problem. Write for more complete information.*



Whirlex Dust Collector completely fabricated and ready for shipment



Whirlex FD and ID fans are designed for heavy, rugged duty

**Fly Ash Arrestor**
**CORPORATION**
204 North 1st. Street • Birmingham, Ala.

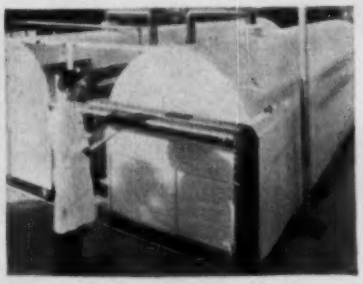
Dust Collectors • Induced Draft Fans
Forced Draft Fans • Exhaust Fans
Self Supporting Stacks • Duct Work

FLY ASH WHIRLEX ARRESTOR


## Powerscope

Begins on page 180

parable piston engine per unit volume and approximately 70% more power per lb. Built to perform at temperatures as low as –65 F, it will have to stand up to powering a truck traveling the miles around the inside of pit walls at an 8% grade carrying 32 tons of ore.



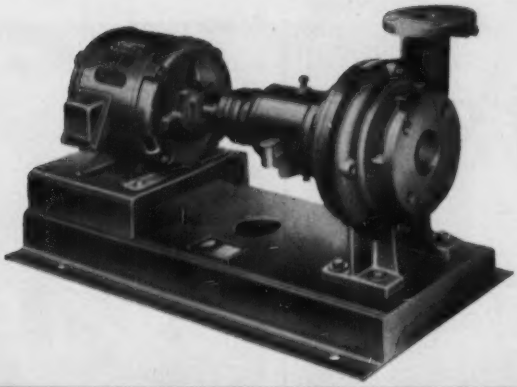
### Large liquid $CO_2$ system installed on West Coast

One of the largest liquid-carbon-dioxide distribution systems is presently in operation on the West Coast, according to W H Grumet, general manager, American Laboratories Div, American Electronics, Inc. System can store carbon dioxide indefinitely under refrigeration and pressurized conditions. It was designed, installed and is serviced by Cardox Div of Chemetron Corp for American Labs.

System comprises a 22-ton mechanically refrigerated and pressurized storage area, and 28 individual outlets located throughout the lab as well as a completely insulated distribution system to these outlets. American Laboratories uses liquid carbon dioxide for cooling by directly expanding it into gaseous form, and by bubbling it through a liquid coolant circulated through a heat-exchanger system.

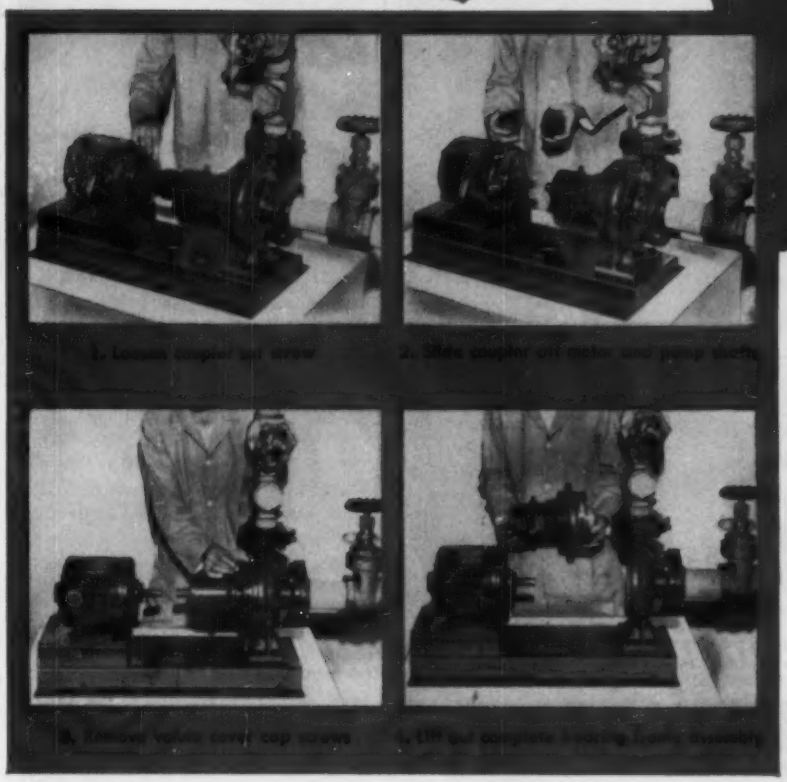
The $CO_2$ system provides extra cooling capacity for rapid temperature shock testing (ambient to –80 F in less than 20 sec) says Gromet. Rapid temperature reduction also saves engineering and test time, reducing overall testing costs, he adds. Storage capabilities of American Laboratories' $CO_2$ system can maintain –65 F in a chamber measuring 37 x 15 x 11 ft with heat loads up to 500,000 Btu per hour.

continued



# EASY TO SERVICE THIS VERTICAL SPLIT-CASE PUMP

# B & G SERIES 1510-B CENTRIFUGAL PUMP



The photos show how easily the complete bearing frame, including seal and impeller, can be removed without disturbing piping or motor leads. The unit is replaceable and interchangeable in all pump sizes within limits of material construction.

Other features of the 1510-B include—

**Mechanically balanced impeller.** Balancing chamber and pressure relief holes in the impeller reduce thrust to a minimum, lengthening pump life.

**Solid-type volute with support foot.** Can be left in pipe line when servicing pump—rugged construction absorbs piping strains.

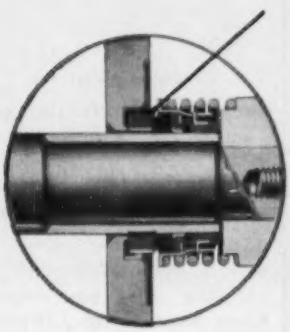
**Anti-friction roller bearings.** Timken bearings handle thrust and radial loads for smoother, quieter, more efficient operation.

**Oil lubrication.** No messy, undependable grease cups—circulating oil lubrication assures positive protection to bearings. Oil level indicator permits visual check.

**Rugged steel base.** Base mounted construction provides a sturdy platform for proper pump and motor alignment.

**100% factory tested.** Every pump hydraulically tested to meet specified conditions of head and capacity.

**Capacities.** To 2000 GPM, heads to 420 ft.



## LEAK-PROOF "REMITE" SEAL

This exclusive feature assures long, trouble-free life—eliminates the customary leakage which occurs when a packing gland is used. A carbon seal ring faces on a "Remite" floating seat—a material developed by B&G, so hard it will scratch glass—wear-proof and corrosion-resistant.

This mechanical seal is self-lubricating. A synthetic rubber bellows seals the shaft. Metal parts are of steel, bronze or stainless steel, depending upon the type of service.

## STOCK PUMPS FOR QUICK SERVICE

Selected sizes of B&G Series 1522, 1531 and 1510-B Centrifugal Pumps are stocked at the factory for immediate shipment. Capacities to 550 GPM, heads to 180 ft. Send for Price and Selection Catalog.

**BELL & GOSSETT**
**COMPANY**

**Dept. GF-36, Morton Grove, Ill.**

*Canadian Licensee: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto 16, Ontario*

Reg. U.S. Pat. Off.



For more facts circle 310 on Reader Service card, p 103

*that's what you want in a fuel...*

*what you get in B&O Bituminous!*

Sure, bituminous coal is power-packed—it's prepared to suit any industrial utilization—its source is most convenient to industry. But, bituminous gives you the *extra* that no other fuel can—*nearly inexhaustible reserves, always available!*

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*Ask our man!* BALTIMORE & OHIO RAILROAD
BALTIMORE 1, MD., Phone: LExington 9-0400


## Powerscope

Begins on page 180

### Water cools isolated-phase generator bus

Water cooling an isolated-phase generator bus has been tested in the Chicago lab of Delta-Star Electric Div, H K Porter Co, Inc. Circular aluminum bus enclosed in a 40-in. aluminum duct has 19-in. diameter, 10,000-amp capacity.

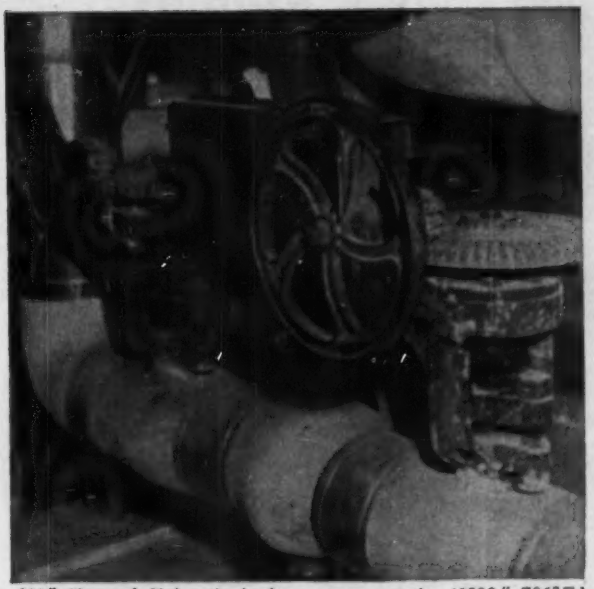
Ordinary tap water was recirculated through the bus at different temperatures and rates of flow during bus-temperature rise were constantly checked. With forced cooling, 15,000 amp flowed through bus while bus-temperature rise was held within allowable limits. The circulating water was cooled in a refrigerating unit. Tap water was used because voltage was low; distilled water or oil would be needed for normal operating voltages.

A liquid-cooled bus saves space. But supplementary equipment such as pump, heat exchanger and pipes is needed and requires attention.

### Gas turbine cleans three miles of buried pipe

A gas turbine successfully removed mill scale, oil paraffin, carbonates and rust from a buried 6-in. petroleum pipe in Wallisville, Texas. Process of sand washing the walls of the 3-mile-long pipe was developed by Klean Kote Co of LaPorte, Texas. Sand under propulsion and suspended in air steam produced pore penetration followed by surface polishing.

In the demonstration, a 365-lb gas turbine produced by The Garrett Corporation's AiResearch Phoenix



*1¼" Hancock Valves in feedwater pump service (6500#-706°F.)*

*¼" Hancock Valves on feedwater flow meter taps (6500#-650°F.)*

*¼" Hancock Valves on main instrument lines (5000#-1150°F.)*

# VALVE DURABILITY MATCHES SUPERCRITICAL PRESSURES

Rated at 5000#-1150°F., Hancock Valves were selected for the new unit of the Philo Plant of Ohio Power Co. where boiler operation is at pressures and temperatures above the critical. *Stay-in-the-line durability* explains why design engineers and steam plant operators prefer these valves for feedwater service, drips, drains, vents and other piping.

Hancock Valves are easily serviced in the line. The bonnet is permanently welded to the body. No bonnet joint to leak. No seal weld to cut—no danger of damage to internal parts. The stellite seat is integral. No seat joint to leak. Seat refinishing is quick and easy with a power drill and reseating tool. The stellite disc is replaceable. The stem resists galling, erosion, thread wear; inhibited packing prevents stem pitting. No need for destructive "cheater" loading—handwheel operation is easy, closure positive against full rated pressure.

Protect personnel, plant and service to customers with durable Hancock Valves. Ask your nearby industrial supply distributor for complete details.

*Sizes: ½" thru 2". OS&Y. Service Ratings: For all pressures up to 5000 psi at 1150°F. Weld Ends.*

**HANCOCK STEEL VALVES**

*A product of*

**MANNING, MAXWELL & MOORE, INC.**

*Valve Division • Watertown, Massachusetts*

*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



For more facts circle 312 on Reader Service card, p 103

# CUSTOM SHEET & PLATE FABRICATION

It takes modern equipment plus craftsmanship and know-how to produce fabrications such as the giant generator housing shown here—illustrative of Kirk & Blum's ability to produce the unusual as well as the conventional types of weldments. In its 170,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, preassemble and finish a wide variety of carbon steel, stainless, aluminum, monel and other alloys assemblies up to ½" thickness. Fifty years of exceptionally varied experience is your added assurance that the job will be done quickly and economically.

Send prints for prompt quotations or write for detailed literature: The Kirk & Blum Mfg. Co., 3233 Forrer St., Cincinnati 9, Ohio.

ELECTRICAL ENCLOSURES AND HOUSINGS
CONTROL PANELS AND DESKS
BREECHINGS • STACKS • AIR AND GAS DUCTS
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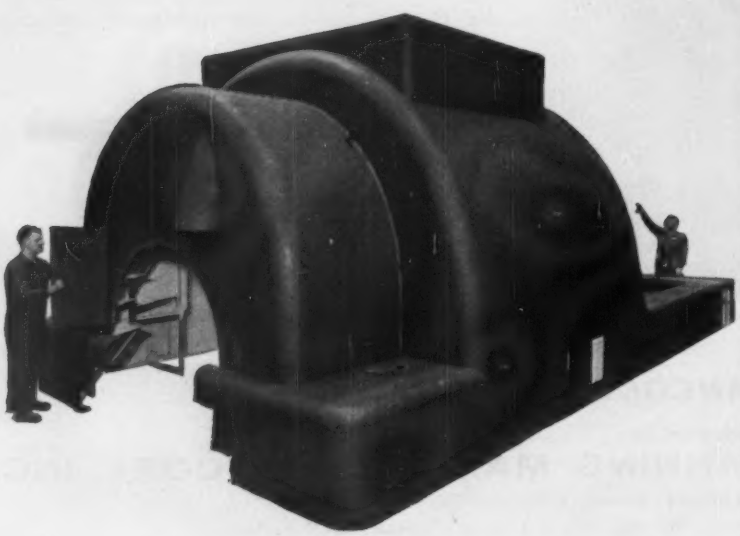
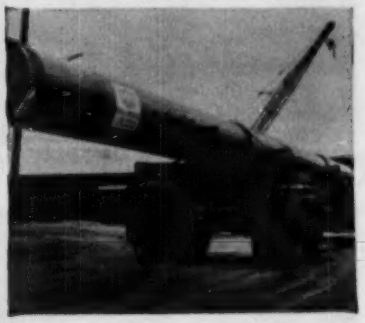





Begins on page 180

Div supplied power. Total weight including trailer was 2500 lb. Turbine produced over 2400 cfm of free air.

Klean Kote had previously used five diesel compressors to supply the air. Each diesel weighed 9000 lb and produced less than 600 cfm of air. Using the gas turbine, the job took slightly more than two hours.



## Union Electric gets 62-ft reheat header

This 62-ft-long hot reheat header, tall as a 6-story building, was fabricated for Union Electric Company of Missouri's Meramec Station by Midwest Piping Company, Inc. It's said to be one of largest single pieces of fabricated piping ever produced west of the Mississippi River.

Header was fabricated in chrome-moly steel, has a 1½-in. wall thickness and diameter of 24 to 27 in. A single-pole trailer with flagged escorts front and rear transported the 15-ton assembly from Midwest plant to Mississippi-River job site.

## Boiler-maintenance device developed in Romania

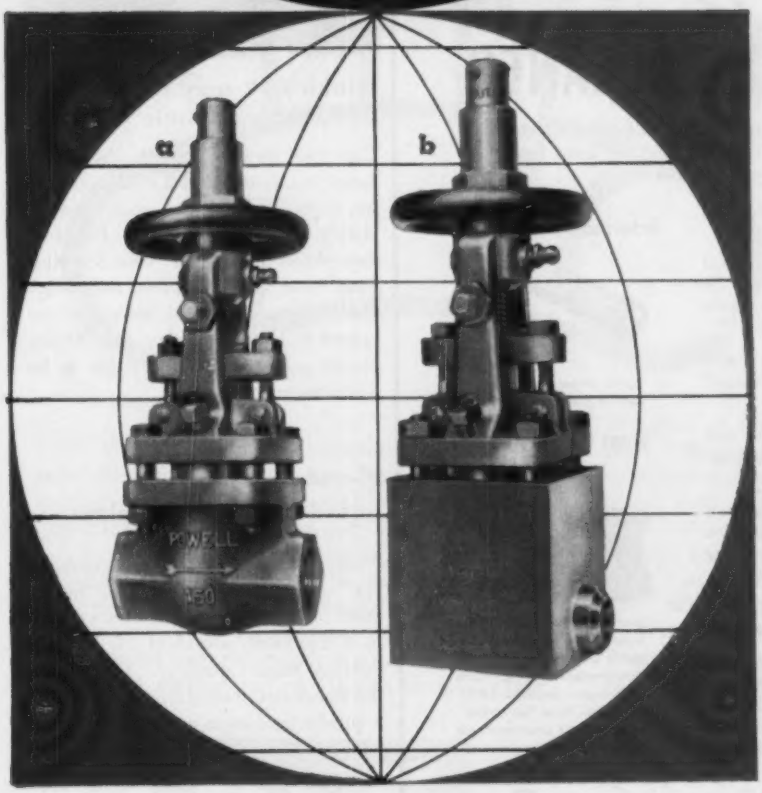
**Vienna, Austria** *(McGraw-Hill World News)* A device for automatic removal of slag and boiler cleaning has been designed in Romania, according to the Romanian periodical *Tehnica Noua*. Device is placed at the bottom of the boiler on the outlet pipe and connected with an injector pump. Water fed into the boiler drives pump's motors. Injector sucks up the clean water from a well and deslagging compound from a tank;

# Performance makes the world of difference

In step with the times, Powell designs and makes valves to successfully handle the fluids that are necessary in the operation of atomic power plants, submarines and merchant ships.

These valves are absolutely leak tight and can be depended upon to render long unfailing service—the result of Powell's constant quality control of materials and manufacturing methods, precision machining, cleaning and degreasing of all parts, and thorough testing.

For complete information consult your nearest Powell valve distributor or contact us.




**a**

Stainless Steel Screwed End Globe Valve for 150 pounds W.P. Because of the specially designed stuffing box, and the special gasket at the body-bonnet joint, these valves are absolutely leak tight. Provided with an extension stem coupling for remote operation.

**b**

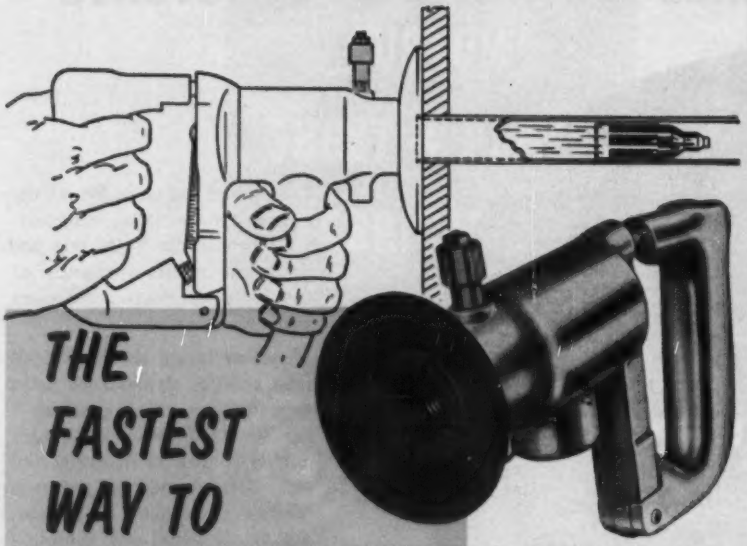
Stainless Steel Block Type Globe Valve for 300 pounds W.P. Butt welding ends. Inner Bell-o-Seal construction protects lower section of stem against any corrosive action of the fluid being handled and makes the valve packless. Valves are fitted with an extension stem coupling so they can be remotely operated.

**THE WM. POWELL COMPANY**
*Dependable Valves since 1846*
**Cincinnati 22, Ohio**

## Powell . . . world's largest family of valves



For more facts circle 314 on Reader Service card, p 103



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John Crane Super-Jet

CONDENSER TUBE CLEANER

"John Crane" Super-Jet tube cleaning equipment offers the simplest yet most effective method for maintaining top heat transfer efficiency in steam condensers for these 5 reasons:

1. **EFFICIENT**—handy gun-and-slug method removes slime or scale in record time.
2. **VERSATILE**—interchangeable nozzles permit water or air operation. Slugs are available in types and sizes to insure positive cleaning under practically all conditions.
3. **SPEEDY**—one man can load an entire bank with cleaning slugs and shoot them through in rapid succession.
4. **ECONOMICAL**—slugs can be used over and over again. Rugged gun is built for long, hard service.
5. **EASY OPERATION**—simple-to-operate gun weighs only 2¼ lbs., does not require a skilled worker and can be used for lengthy periods without fatigue.

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Crane Packing Co., 6430 Oakton Street, Morton Grove, Illinois (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

**Interchangeable Nozzles**

Air or water operation—effective pressures 50-200 psi.

**Slugs For All Services**

Spool-type for normal slime removal, bullet-shaped for heavy or thick slime deposits and scraper-type for scale and mineral deposits. Latter two slugs have "jet action" holes that air or water-flush away deposits as removed.

John Crane

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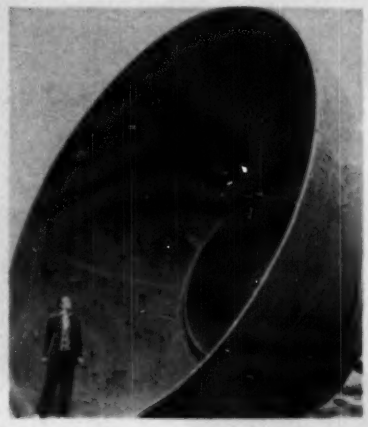
CRANE PACKING COMPANY




a cock handles closing. Injector gets steam from a distributor.

Control valve is saturated with residues and fitted with two elastic valve flaps alternately working. A lever driven by the piston's engine lifts the valves, allowing water and impurities to flow from the boiler into the device.



### Hinkley Pt may be first 500,000-kw atomic station

Cap that dwarfs a man, above, belongs to one of 12 heat exchangers to be installed in new atomic-power station at Hinkley Point, England. Completed exchanger will be 90-ft long, have a 21-ft diameter and weigh over 300 tons. British station is expected to be world's first 500,000-kw atomic-power station. It's due to be commissioned by 1962.

### Florida will have liquid-air-separation plant

Plans to construct the first commercial liquid-air-separation plant in the state of Florida were announced by R R Lenhard, president of Air Reduction Sales Company. The multi-million-dollar installation will have a production capacity of 25 tons of high-purity liquid oxygen per day, plus liquid nitrogen and liquid argon.

This facility, the newest in Airco's network of liquid-air-separation plants, will serve many industries in the Florida area. Tampa was chosen

# MADE BY MEN WHO KNOW TUBING

B&W Welding Fittings manufacturing is integrated with the Division's own tube-making and steel-making facilities. Consider the relation between tube-making and the manufacture of welding fittings . . . in addition to knowing welding fittings manufacturing, B&W knows of the making of tubing from which fittings are produced. This knowledge plus integration of facilities permits B&W to provide superior fittings, completely quality-controlled, matched to end-use service. It also means on-time deliveries of fittings made from tubing of the specialized steels because B&W can closely control manufacturing schedules from melt to the shipment of the finished product.

B&W Welding Fittings and Flanges are available through qualified distributors in carbon steel and the B&W CROLOYS in a complete range of types and sizes. Write for B&W Bulletin FB502. The Babcock & Wilcox Company, Tubular Products Division, Welding Fittings Plant, P. O. Box 230, Beaver Falls, Pennsylvania.

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- Handles temperatures from −60°F. to +450°F.
- For 60° throttling or 90° on and off.
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- Low in cost, weight and maintenance.

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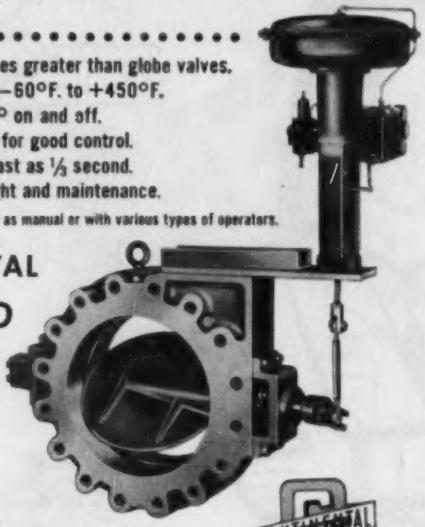

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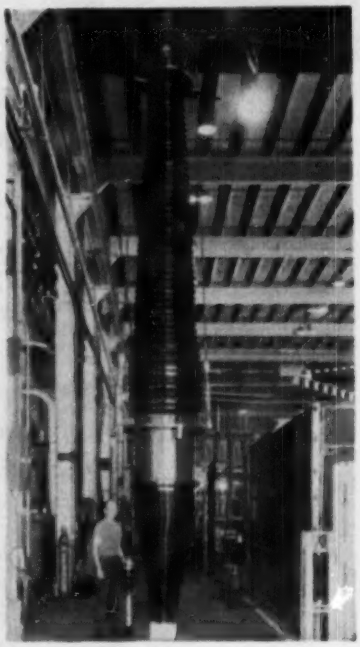
## Powerscope

Begins on page 180

as site for this new plant because of its central location, facilitating distribution throughout the state. Completion is scheduled for this summer.



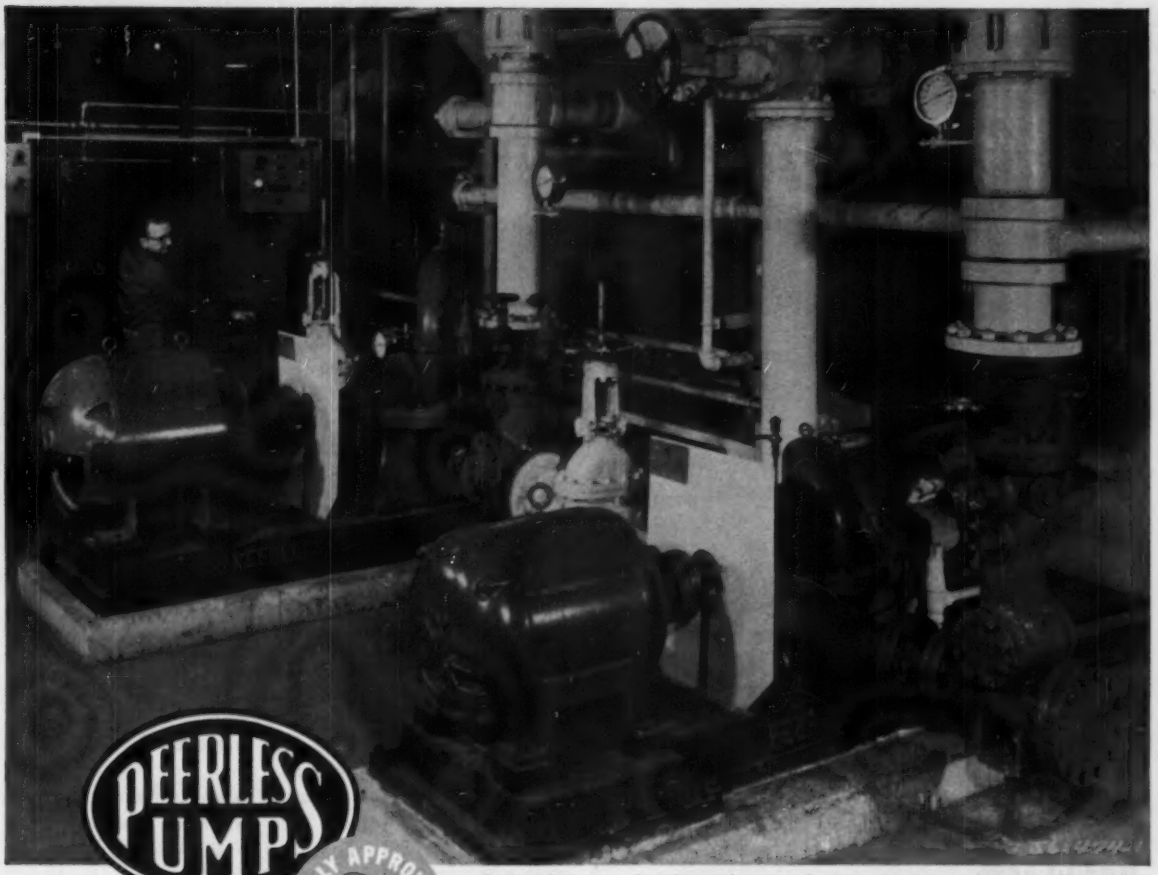
### GE designs bushing for EHV transformer

Huge 650-kv bushing dwarfs workman and 23-kv bushing beside it. Designed by General Electric Company for Project EHV, bushing has successfully passed all design tests in the company's high-voltage lab at Pittsfield, Mass. This unit, with two similar ones, will be mounted on a 40,000-kva power transformer soon to be installed at Project's northern substation.

Believed to be largest, highest-rated bushing ever built, unit weighs 10,000 lb and has a bil rating of 2050 kv. It is 28 ft long. Project EHV, a prototype transmission system, will begin experimental testing at 460 kv, later going as high as 750 kv.

### All-aluminum unit will distill sea water

An all-aluminum sea-water-distillation unit, the first known application




PEERLESS FULLY APPROVED FIRE PUMPS...

Prudential Insurance Co. takes no chances on fire in its recently erected Chicago Office Building. Peerless pumps give immediate protection against fire automatically, without human attention.

# HOW TO DEAL WITH A FIRE BEFORE IT STARTS!

To insure adequate protection against the hazards of fire, a qualified independent fire protection system is a must. And to be doubly sure of the best system, the vital heart of the unit, the pump, should be the best money can buy. That's where Peerless *fully-approved* fire pumps excell.

Throughout a third of a century, Peerless fire pumps have attained an enviable and pre-eminent reputation in protecting all types of buildings, plants and warehouses. Put this know-how to work on your protection problem. See how Peerless' combination of top quality fire pump equipment, exacting engineering application and nationwide service can serve you best. In many instances, the savings effected thru more favorable insurance premiums can pay for the installation. For fire pumps at their very best look to the leader, look to Peerless. Write for bulletin B-1500 today.

Available with steam turbine, engine or electric motor drives, Peerless fire pumps are available for high pressure sprinkler systems, or foam smothering systems in every kind of commercial, or industrial installation.

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POW



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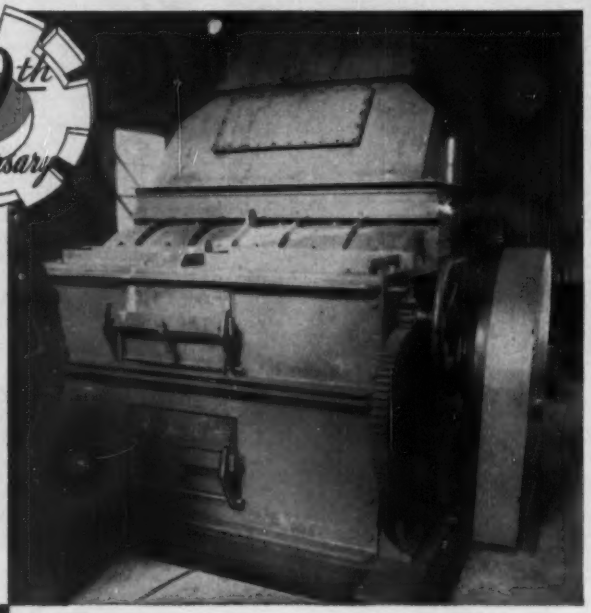
# CRUSHING FACTS

from *American* PULVERIZER CO.

50th Anniversary



USER REPORTS

**"We've reduced 2,521,000 tons of 2" N & S coal to a ¾" product. Crusher has given satisfactory service. Rings and screens have been renewed only once."**

Replacement parts on this American AC-7C Rolling Ring Crusher after crushing 2½ million tons of coal have cost only $0.0016 per ton (1/6th of a cent).

There's good reason for performance records like this. The American originated rolling shredder ring efficiently splits coal instead of crushing it. Coal spends less time in the crusher; therefore, there is less attrition in the crushing chamber and less wear on the screens. Further, the rings are reversible for double wear. In addition, the effectiveness of the crushing elements permit slower operation speeds.

*Our engineers will analyze your reduction problem. No obligation to you.*

American PULVERIZER COMPANY

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

1349 MACKLIND AVE. ST. LOUIS 10, MO.




of aluminum for this purpose, is being developed by the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Virginia. Present equipment is made of cupronickel. The aluminum unit should be lighter, have greater capacity, better fuel economy.

The aluminum unit uses a vapor-compression-distillation process which conserves latent heat of vaporization and requires less fuel.

## Jubilee speaker sees future oil-powered home

New England oilmen gathered by the hundreds this past spring to celebrate Oil Heat Institute's Diamond Jubilee. Boston was the scene of the first of a series of regional Jubilee luncheons held in major cities across the country.

Featured speaker for the luncheon was C H Burkhardt, National Secretary, Distribution Div, Oil Heat Institute of America, Inc. Burkhardt told the New England group that the Jubilee milestone was marked by an awareness of oil heating's future. The American house of the future could be completely oil-powered, with low-cost heating oil furnishing energy for heat, air conditioning, water heating, cooking and clothes drying. An efficient oil-fired turbine will furnish self-sufficient abundance of electric power for lighting and operating appliances.

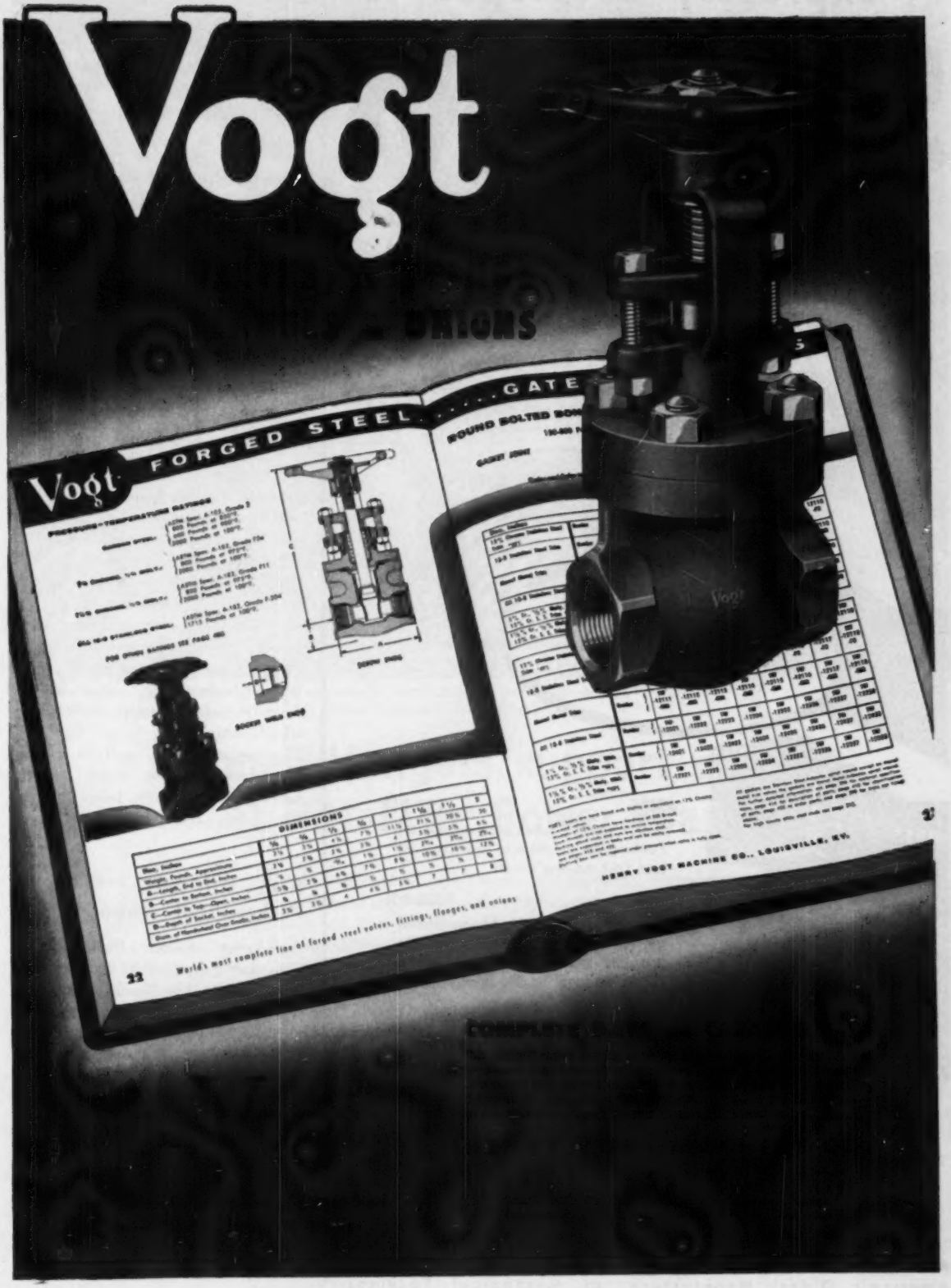
## Underwater lab will use atomic-reactor-core mockup

Underwater lab facility consists of 11-ft-dia 40-ft-high tank containing 30,000 gal of reactor-grade demineralized water and full-scale mockup of ⅛ of Pathfinder Atomic Plant reactor core.

Located at Allis-Chalmers Co's Greendale Laboratories, facility will help develop underwater fuel-element-handling techniques and devices.

Mockup core will be at same depth as core of power-reactor vessel when immersed in lab's tank. Containing 14 simulated boiler fuel elements, 15 simulated superheater fuel elements

# Things You Should know about



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# 5 CHESTERTON PACKINGS expressly developed for STEAM

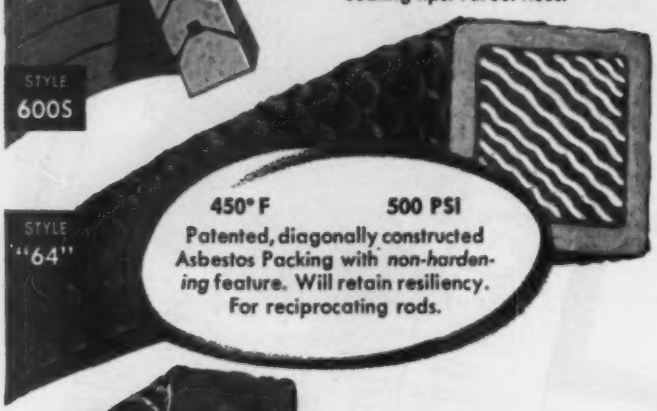
HEAT . . . . . PRESSURE

1000°F 2000 PSI

A 95% pure asbestos braided yarn with monel wire insertion. Mica lubricated. For extreme heat and pressure service.

550°F 1000 PSI

Improved self-sealing moulded Asbestos Packing with multiple feather sealing lips. All services.




450°F 500 PSI

Patented, diagonally constructed Asbestos Packing with *non-hardening* feature. Will retain resiliency. For reciprocating rods.

350°F 125 PSI

Soft, highly lubricated Asbestos Packing for medium to low pressure and fast moving shafts.

750°F 1000 PSI

Compressed Asbestos Sheet. Homogeneously constructed with complete graphite impregnation. Cuts easily. *"Lasts as long as the iron."*

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**A. W. CHESTERTON CO., 7 ASHLAND ST., EVERETT 49, MASS.**
America's Oldest Manufacturer of Mechanical Packings

For more facts circle 321 on Reader Service card, p 103




Begins on page 180

and two control rods, mockup will permit latches for testing fuel elements, developing and perfecting underwater-handling tools and refueling techniques.

## Electric-heating market may reach 6,000,000

A goal of 6,000,000 electrically heated homes is predicted for the close of this decade by NEMA Electric House Heating Equipment Section. Based on the industry's growth of the last ten years, from 100,000 electrically heated homes in 1950 to 850,000 this year, retail installed costs are expected to reach a grand total of $750,000,000 in 1965.

Chairman of NEMA's House Heating Equipment Section, D F Kreiser, predicts that all homes in the '70's will have electric heat. So far, home owners have invested $23,000,000 in supplementary heating alone, he said.

Key to future growth of electric heating is the removal of all obstacles in purchasing equipment. And today electric industry's sales allies are eagerly introducing electric heating to home owners, says Stanley Aronson, sales manager, Berko Electric Manufacturing Corp. The electric industry finds itself in a very favorable situation since electric heating is not only being bought but is also eagerly being sold.

## Bailey will sell Packard Bell computer

Agreement between Packard Bell Computer Corp and Bailey Meter Co gives Bailey Meter exclusive right to sell Packard Bell PB 250 general-purpose computer in the power-plant field. This agreement will let both companies sell the computer for other process - industry applications. Computer is said to cost one-third as much as comparable units, have solid-state circuitry, low component count and no moving parts for added reliability. Unit requires only 50 w for operation, will fit into any standard control cabinet.

Companies expect to supply the

Hot reheat pipe of new 325,000 KW unit No. 5 at Pacific Gas and Electric Company's Pittsburg Power Plant in California, showing line-up of 3 Grinnell Constant Support Hangers.

# Grinnell Hangers support piping at Pittsburg Power Plant

Grinnell manufactures a complete line of engineered pipe hangers and supports. Where reactive forces at terminal points must be kept within specified limits, Grinnell Constant Support Hangers are recommended. They are designed to provide an exact supporting force equal to the pipe load throughout the entire range of travel.

When pipe lines are subject to vertical movement and restrictive conditions do not require the use of a constant support type, Grinnell Variable Spring Hangers are recommended. They should be designed to support not less than 85% or more than 120% of the designed load for the total travel.

When necessary to prevent abnormal movement or vibration in pipe lines, Grinnell Sway Braces of the energy-storing, instant-acting, counter force type are available.

Grinnell maintains a staff of trained technicians; provides highly skilled assistance and advice right from the design stage; offers experienced field engineering service. Call on Grinnell next time. Grinnell Co., 277 West Exchange St., Providence 1, R. I.

Closeup of Grinnell Variable Spring Hanger supporting boiler feed pipe.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Pipe Fittings, Valves, Pipe Hangers, Prefabricated Piping, Unit Heaters and Piping Specialties
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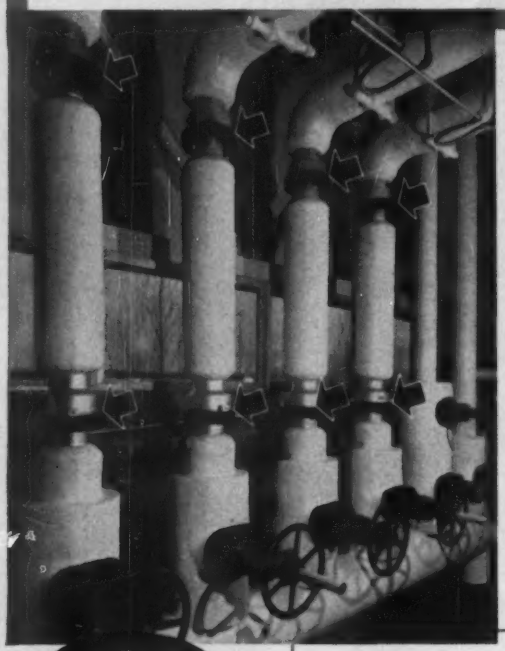
# Barco Solves Boiler Piping Expansion Problem



## Relieves Strain on Valves

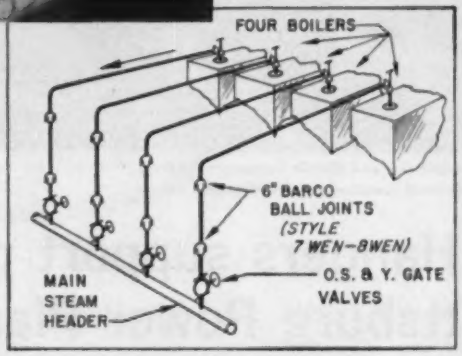
This photograph shows an interesting new installation of eight Barco Flexible Ball Joints (see arrows) on four 250 psi boiler steam lines in a West Coast industrial plant. The schematic diagram (below) shows the piping layout.

Due to the fact that operation of individual boilers is intermittent, complicated expansion, contraction, and torsional movements occur in the piping. All of these movements are easily accommodated with the aid of the Barco Joints, relieving reactive forces on the valves.

BARCO

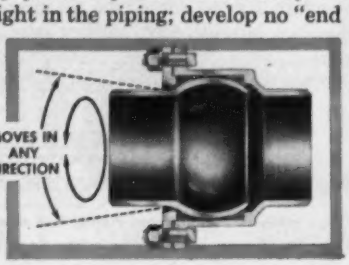
**BALL JOINTS**

1. Handle Expansion
2. Relieve Torsion




**PROBLEM**—Originally, in the plant shown above, it was thought that the "spring" in the long runs of piping would take care of *thermal expansion* and *torsional stresses*. SUCH WAS NOT THE CASE. Serious trouble was encountered, tending to crack valve flanges and twisting so they would not seat tight.

**ANSWER**—Barco Ball Joints solved the problem, LOGICALLY, SIMPLY, ECONOMICALLY. These rugged all-steel joints have no thin wall sections, no critical points of fatigue, no rubber seals. They are practically indestructible. They provide points of flexibility in piping. Easy to engineer. They fit right in the piping; develop no "end thrust"; require no expensive anchoring. Sizes and styles to meet your requirements. *Send for catalog and information.*

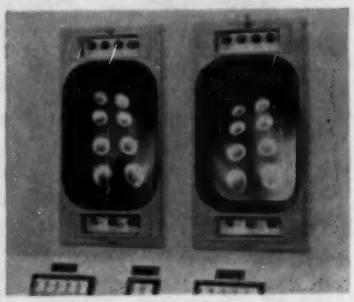



**BARCO MANUFACTURING CO.**
522-G Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal


## Powerscope

Begins on page 180

power industry with a unit for monitoring processing temperature, pressure, flow rate and other variables. It could also be connected to controllers for closed-loop control to maintain optimum operating efficiency.



### Boilers undergo 24-hr vigil

At Scattergood Steam Plant of Los Angeles Water and Power Dept, operators maintain constant watch on fires inside plant's boilers from remote control room. During startup, operator gets a clear view of all 16 burners in each unit. He can see if every burner lights correctly and check for plugged burner tips. Cracks developing in fire rings or back-burning areas in the windbox during operation can be easily viewed and located for servicing.

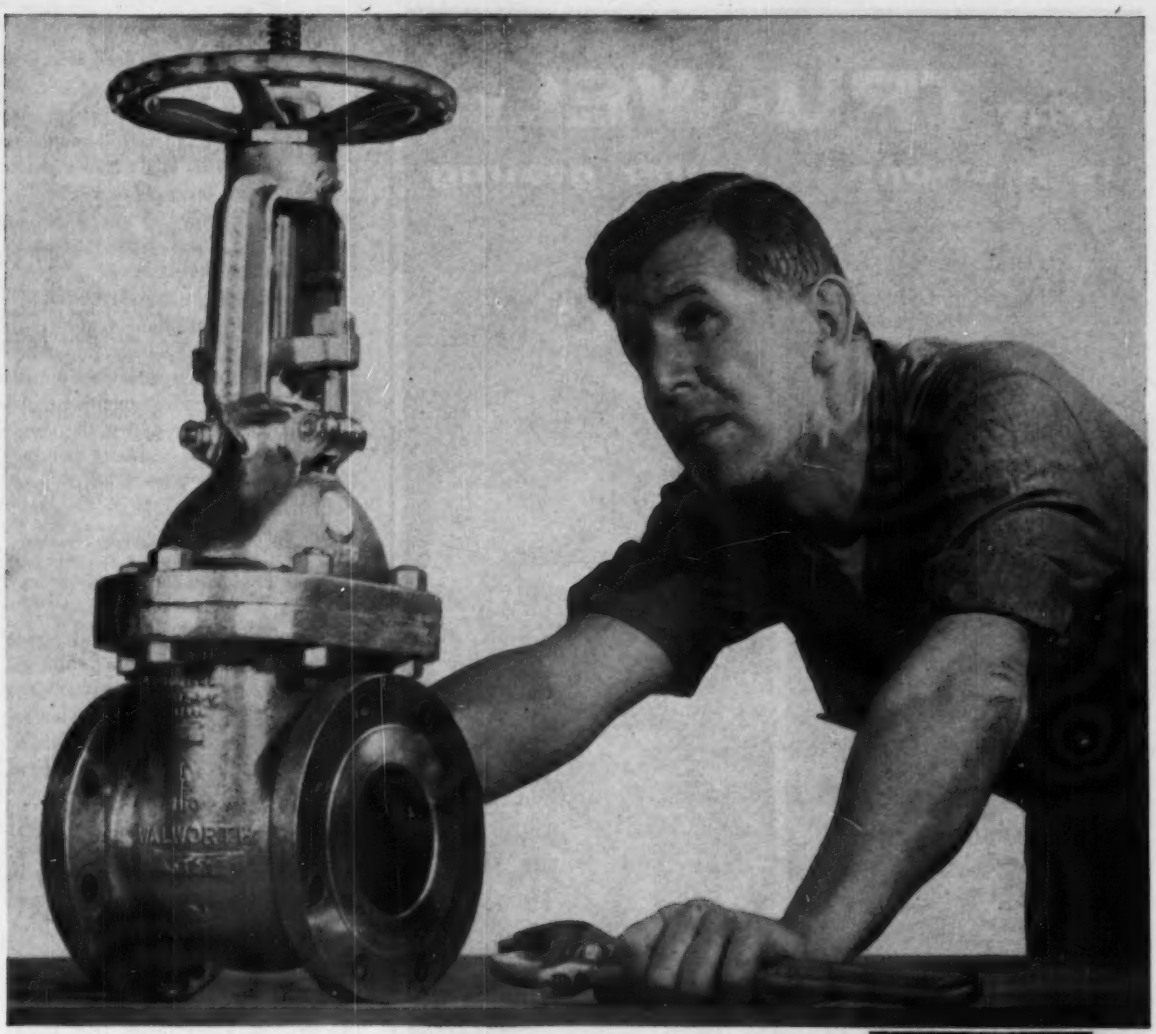
System consists of four Kin-Tel Vidicon cameras mounted outside boilers directly opposite burners. Dividing wall splits boiler furnace, so two cameras are used for each boiler. Air-cooled window in boiler wall serves as the viewing port.

Each camera sends its picture to a monitor located in remote firing station's control room. At one glance operator can see 32 burners and immediately determine any malfunction. Cameras have special filters to detect both oil and gas flames.

Operators at the Scattergood Plant, with the aid of monitors, make a fuel switch in two or three min—a job that formerly took a full half-hour.

### Data machines use computer language for toll calls

Two IBM tele-processing data machines talk to each other in computer



*the*

## WALWORTH CUSTOMER

*has to have trouble-free valve operation*

*. . . and here's how he makes sure of it on low pressure*

## CAST STEEL GATE VALVES

Before the Walworth Customer selects cast steel valves, he wants to know: What features reduce turbulence and pressure drop? Can body-to-bonnet joint be reassembled in the field without danger of misalignment? Is stuffing box deep enough to assure tightness and maximum life of packing?

In the Walworth Cast Steel Gate Valves he finds streamlined ports to fight turbulence and pressure drop. He finds flat gasket and male-and-female joint closures that assure correct realignment in reassembly. He finds stuffing box depth adequate-plus for tightness and packing durability.

Walworth is proud to please "hard-to-please" customers like this. If you, too, have these exacting standards in valves we'd like you for a Walworth Customer. For details of Walworth Cast Steel Gate Valves, or any of the complete line of Walworth Valves, contact your Walworth Distributor, or write

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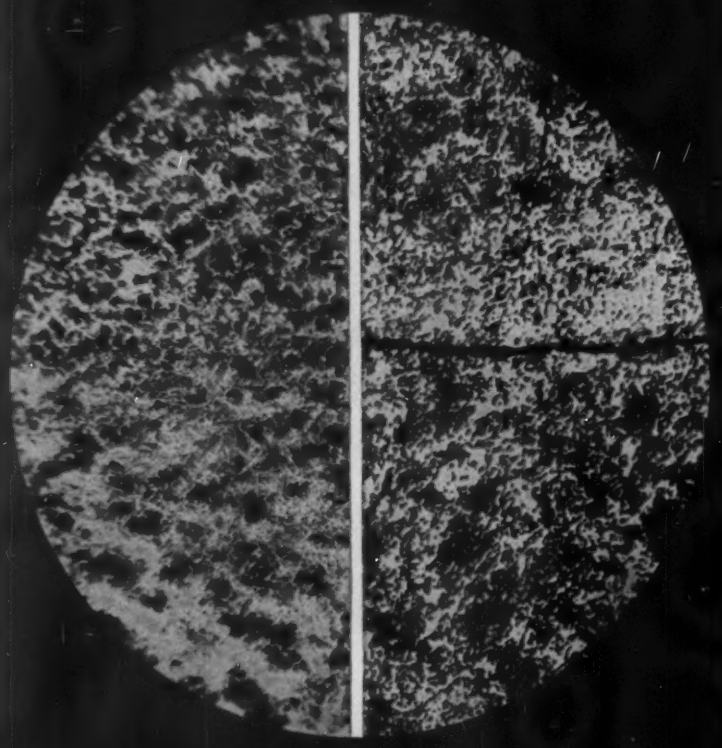
For more facts circle 324 on Reader Service card, p 103

# why TRU-WELD is a stronger, better grating



photomicrograph of grating welds

This enlargement of the weld area in TRU-WELD grating shows how solidly the metals have joined. Cross bar and bearing bar have fused into a strong, moisture- and vibration-proof weld.

Enlargement of an incomplete weld area. Note the line of separation between bearing bar and cross bar. Heavy traffic and vibration can easily separate such a weld.

Tru-Weld grating is stronger because it is *made* that way. Its added strength comes from a manufacturing process that completely fuses the metal at cross bar-bearing bar joints and holds the bars to exact spacing. The result is grating that stands up under excessive vibration, heavy traffic or in areas where corrosive fumes and moisture are a problem. And Dravo Tru-Weld grating *costs no more.*

Complete estimating, layout and fabricating services are available. Immediate delivery from stocks maintained at nearby Joseph T. Ryerson Service Centers will help you meet exacting construction schedules.

For more information on this new, stronger grating, call the Dravo representative in your area, or write DRAVO CORPORATION, PITTSBURGH 25, PA.

**DRAVO**
CORPORATION


## Powerscope

Begins on page 180

language via regular toll-telephone calls. Magnetic - tape - transmission terminal sends business and scientific data at a rate of 150 characters or thirty words a sec—fifteen times as fast as human speech.

IBM data transceiver equipped with a dialup telephone feature can transmit ten 80-column punched cards a minute. In each case a twin device at other end of telephone circuit, which may be across the country, automatically recreates original magnetic-tape or punched-card data. Both terminals can operate over telegraph lines.

---

**"Cyclotherm presents** heat transfer & cyclonic combustion," film released by the Cyclotherm Div of Crane Co, is available for viewing from R P Leonard, sales manager, Cyclotherm Div of Crane Co, First Street, Oswego, N. Y.

**Ingersoll-Rand pumps** is celebrating 100th anniversary this year. In 1860, original Cameron Works was established in New York City.

**Dow Corning Corp.** Midland, Mich. manufacturer of silicones, has formed two overseas subsidiaries, Dow Corning S A, Panama and Dow Corning A G, Basel, Switzerland.

---

*"Did you have a bad day at the plant, dear?"*

# Why a Steam Trap Has to Handle "Air"

## Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

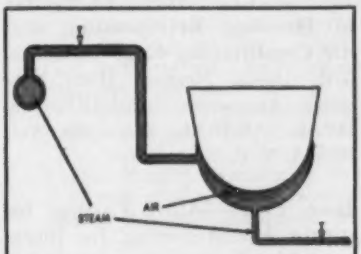



Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

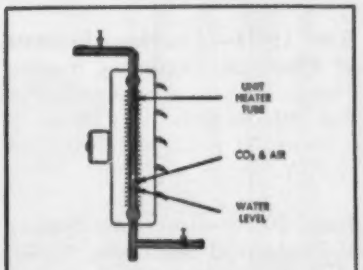



Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both, at steam temperature, as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. $CO_2$ gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. $O_2$ aggravates the situation. See Figure 2.

**TABLE A—How air reduces steam temperature.**

| Gauge Pressure | Temp. of Steam with No Air Present | Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume) | |
|---|---|---|---|
| | | 10% | 30% |
| 10.3 | 240.1 | 234.3 | 220.9 |
| 25.3 | 267.3 | 261.0 | 246.4 |
| 50.3 | 298.0 | 291.0 | 275.1 |
| 75.3 | 320.3 | 312.9 | 295.9 |
| 100.3 | 338.1 | 330.3 | 312.4 |

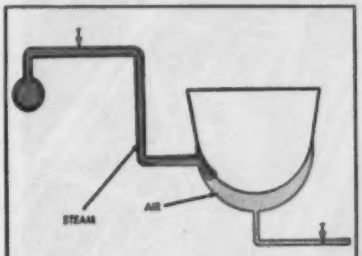



Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

### Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

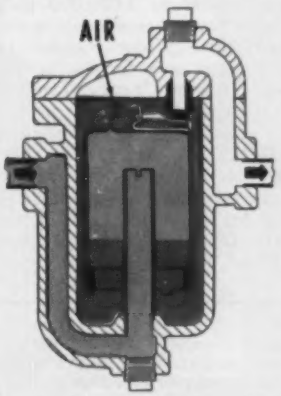
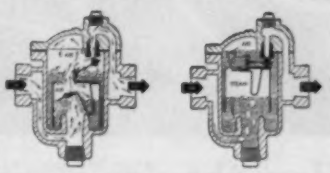



Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



*Thermostatic vent open.* *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

### Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

* * *

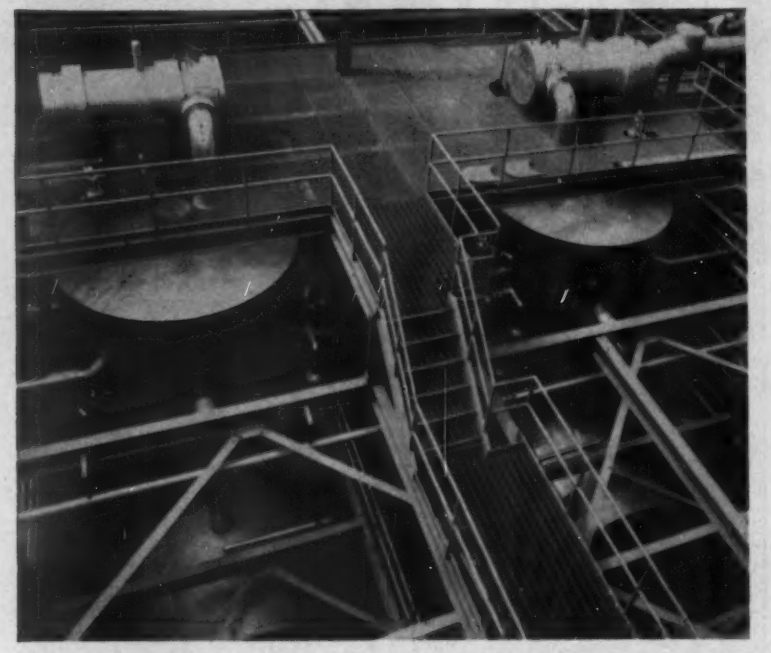
The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8126 Maple Street, Three Rivers, Michigan.

**ARMSTRONG STEAM TRAPS**

See our Catalog in Sweet's Plant Engineering File

For more facts circle 326 on Reader Service card, p 103

# FLUIDICS* AT WORK



## How they're saving feedwater dollars at L.A.'s new Scattergood Steam Plant

Each of these two 12'-diameter, 1,036,250-lb/hr-capacity Permutit spray-type deaerators, nests atop its own 160,000-lb. storage tank in the new Scattergood Steam Plant at Los Angeles. The only open direct-contact-type heater with five closed heaters operating on the regenerative cycle, each deaerator operates at 20 psia to 52.8 psia. Design pressure is 100 psig, ASME code.

These deaerators process boiler feedwater for normal throttle steam conditions of 1800 psig at 1000° F with 1000° F reheat.

The City of Los Angeles can't afford to have corrosive oxygen or $CO_2$ in that water.

And it doesn't, because Permutit deaerators are *guaranteed* to remove all free $CO_2$ and to reduce oxygen to less than 0.005 m. per liter.

**Save money**

These deaerators save operating dollars because they have several advantages over tray or other types of deaerators. Maintenance is minimized, due to simplicity of design. Uniform, wasteless distribution of steam through water in scrubber, at *all* rates of flow from zero to full capacity. No water hammer, no rumbling—in short, quiet operation.

Besides these heaters, two more Permutit deaerators are used at Scattergood to prepare feedwater for evaporators.

Ultimately, Scattergood will have four generating units producing a total of 1,200,000 KW, almost equalling Hoover Dam. There's no room for boiler troubles in this kind of operation.

**30-page bulletin**

You can get the same feedwater purity and dollar savings, with Permutit deaerators (3000 to 3,000,000 lb/hr) and other water treatment facilities available through our Fluidics program. To start, send for our fact-filled 30-page bulletin, "Spray Type Deaerating Heater."

For more information, write PERMUTIT Division, Dept. PO-60, 50 West 44th Street, New York 36, N. Y., or call your local Permutit representative. In Canada: The Permutit Company of Canada, Ltd., 207 Queens Quay West, Toronto, Ontario.

*FLUIDICS is a complete, imaginative Pfaudler Permutit program which economically provides practical answers to problems involving fluids and gases.

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# Calendar

**June 10-26—British Exhibition,** sponsored by Federation of British Industries, Coliseum, New York. Details: A A Schechter, 551 Fifth Ave, New York 17, N. Y.

**June 13-14—Illuminating Engineering Society,** Canadian Regional Conference, Nova Scotian Hotel, Halifax, N. S. Details: H Lushington, Canadian General Electric Company, Ltd, Halifax, N. S., Canada

**June 13-15—American Association of Cost Engineers,** Annual Meeting, Rice Hotel, Houston, Texas. Details: E D Shanken, AACE, Durham, N. H.

**June 13-15 — American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc,** 67th Annual Meeting, Hotel Vancouver, Vancouver, British Columbia. Details: ASHRAE, 234 Fifth Ave, N. Y. 1, N. Y.

**June 19-21—Alloy Casting Institute,** Annual Meeting, The Homestead, Hot Springs, Va. Details: H Schor, 114 E 40 St, N. Y. 16, N. Y.

**June 19-22—American Institute of Chemical Engineers,** Spring Meeting, Del Prado Hotel, Mexico City. Details: AICHE, 25 W 45th St, New York 36, N. Y.

**June 19-24—American Institute of Electrical Engineers,** Summer General Meeting. Chalfonte-Haddon Hall, Atlantic City, N. J. Details: R C Mayer, 51 E 42nd St, New York 17, N. Y.

**June 20-22—American Society of Mechanical Engineers,** Applied Mechanics Conference, Pennsylvania State Univ, University Park, Pa. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

**June 20-24 — Cleveland Engineering Society,** National Invention's Exhibition and Creativity Conference, Cleveland Engineering and Scientific Center, Ohio. Details: J H Gepfert, Cleveland Engineering Society, 3100 Chester Ave, Cleveland 14, Ohio

continued

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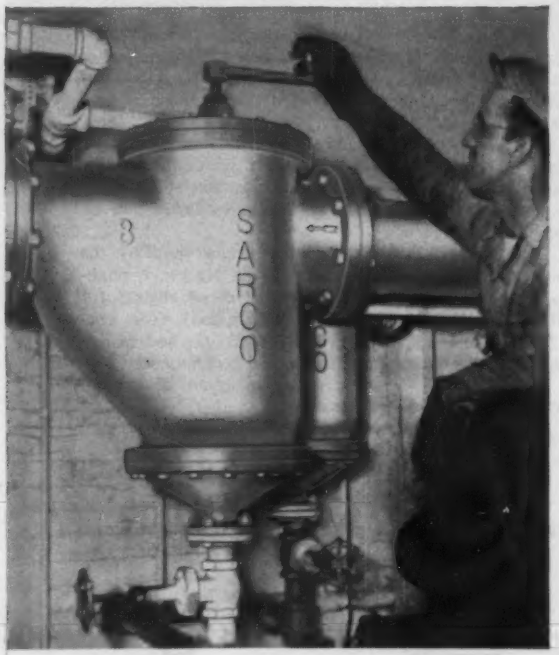
# SARCO TOPICS

## How correct strainer selection protects equipment, maintains fluid flow, and prevents shut-downs

### Strainers for wash water for power plant condensers cleaned without shut down




Sarco Type VRS Rotary Scraper Strainers enable operators to clear the screens with a few turns of the crank, without shutting down the line or dismantling the strainer.

Sizable quantities of water are required for cleaning condenser water screens at a power plant in California. Sea water is pumped for the purpose and must be freed from debris and sea life such as mussels and sardines. Further, any screening devices used must be capable of cleaning without shut-down.

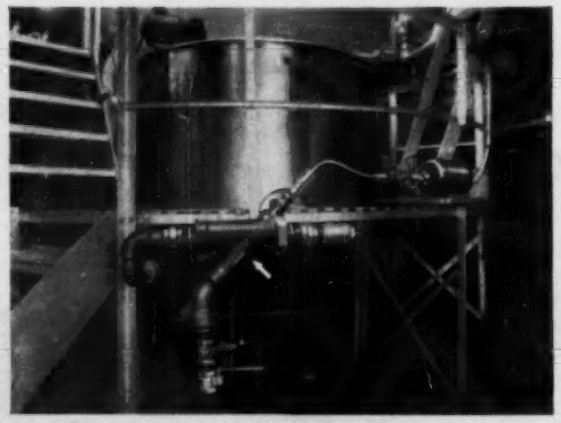
These problems were met by installing two Sarco type VRS scraper strainers ahead of the wash water pumps. This type of strainer is cleaned by rotating a spiral blade either manually or by motor drive. Motor-operated rotary-type strainers make it possible to clean the strainer continuously. The blade scrapes the screen clear, and collected solids are blown down from the strainer as required. Clean screens minimize pressure drop. The Sarco strainer installation has materially reduced maintenance hours and insured against temporary shut-down caused by clogged strainers.

### Helical scraper knife clears screen without shutdown in East Chicago Air Conditioning System

Offices of the Inland Steel Company, at East Chicago, Indiana, are cooled with air conditioning units of 7½ tons and larger. Water for condenser cooling is pumped in from Lake Michigan.

Although passing through traveling screens, the incoming water still contained fine sand which clogged the screens. Frequent cleaning was required, and every now and again the units were practically out of service.

Plant engineers found their answer in Sarco Rotary Scraper Strainers, Type VRS. These units incorporate a hand-operated helical scraper knife within the cylindrical strainer screen. These scrapers made it possible to keep the strainers clean simply by cranking the scraper a few turns at regular intervals. Sand scraped off the screen is blown clear and discharged at pressure through a manually operated valve to waste. Now it is not necessary either to dismantle the strainer or shut down the unit.



**IN PROCESS APPLICATION** This Sarco motor operated-Scraper Strainer, Type SRS, is used to strain chocolate syrup in a processing application, providing continuous flow of fluid without shut-down for maintenance. 2167

*For information on Sarco strainers, contact your Sarco sales representative, district office, or distributor; or write—*

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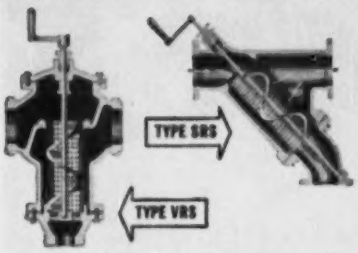
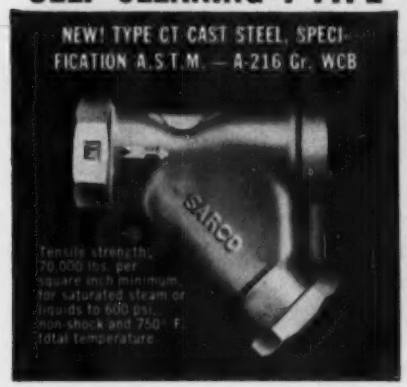



## SELF-CLEANING Y-TYPE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## Calendar

Begins on page 202

**June 20-24—American Society for Engineering Education,** 68th Annual Meeting, Purdue University, Lafayette, Ind. Details: Purdue University, Lafayette, Ind.

**June 25-July 5—Instrument Society of America,** 1st International Congress for Automatic Control, AACC sponsored with ASME, IRE and AICHE cooperating, Moscow, U.S.S.R. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**June 26-July 1—American Society for Testing Materials,** Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J. Details: F F Van Atta, 1916 Race St, Philadelphia 3, Pa.

**July 6-8—Conference on Civil Engineering Education,** sponsored by Cooper Union, ASCE, ASEE, U of Michigan, at Ann Arbor, Mich. Details: Dr F A Wallace, Cooper Union, New York 3, N. Y.

**July 11-12—Conference on Response of Materials to High-Velocity Deformation,** sponsored by Physical Metallurgical Comm., Inst of Metals Div, TMS, Estes Park, Colorado. Details: AIME, 29 W 39th St, New York 18, N. Y.

**August 9-12 — American Institute of Electrical Engineers,** Pacific General Meeting, El Cortez Hotel, San Diego, Calif. Details: H R Hughes, 1109 Alexandria Dr., San Diego 7, Calif.

**August 15-17—American Society of Mechanical Engineers and American Institute of Chemical Engineers,** Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N. Y. Details: L S Dennegar, 29 W 39th St, New York City

**Sept 7-9—American Society of Mechanical Engineers,** Automatic Control Conference and Exhibit, Mass. Institute of Technology, Cambridge, Mass. Details: L S Dennegar, ASME, 29 W 39th St, N. Y.

**Sept 7-15—2nd Coliseum Machinery Show,** Coliseum, Chicago,


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Illinois. Details: A B Perkins, 2807 Sunset Blvd, Los Angeles 26, California.

**Sept 11-16—Illuminating Engineering Society,** National Technical Conference, Penn Sheraton Hotel, Pittsburgh, Pa. Details: A D Hinckley, IES, 1860 Broadway, New York 23, N. Y.

**Sept 14-17—2nd Southeastern Annual Maintenance and Engineering Show,** sponsored by AIPE, Maintenance Council, AWS, State Fair Arena, Raleigh, N. C. Details: J Harden, P. O. Box 3173, Greensboro, N. C.

**Sept 15-16—American Institute of Mining, Metallurgical and Petroleum Engineers, Inc,** Engineering Management Conference, Morrison Hotel, Chicago, Ill. Details: AIME, 29 W 39th St, N.Y. 18, N.Y.

**Sept 15-16—American Society of Mechanical Engineers,** Engineering Management Conference, Morrison Hotel, Chicago, Ill. Details: ASME, 29 W 39th St, New York 18, N. Y.

**Sept 21-23—Power Conference,** sponsored by ASME, AIEE, Bellevue-Stratford Hotel, Philadelphia, Pa. Details: ASME, 29 W 39th St, New York 18, N. Y.

**Sept 26-30—Instrument Society of America,** 3rd Instrument-Automation Conference and Exhibit, 15th Annual Meeting, Coliseum, New York City. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**Sept 27-30—Association of Iron and Steel Engineers,** Iron and Steel Exposition, Cleveland Public Auditorium, Cleveland, Ohio. Details: ASIE, 1010 Empire Building, Pittsburgh 22, Pa.

**Oct 6-7 — National Association of Corrosion Engineers,** Annual Western Region Conference, Sheraton-Palace Hotel, San Francisco, Calif. Details: T J Hull, 1061 M&M Building, Houston 2, Texas

continued


## How to return condensate a full mile at 280° F.

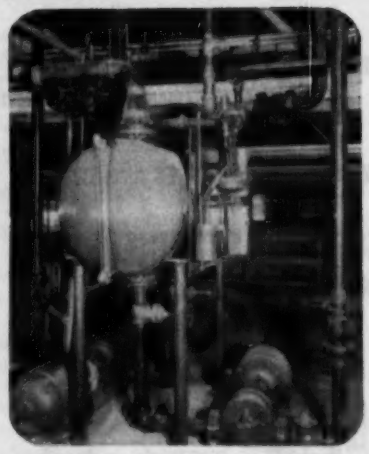

Photo courtesy of A. M. Byers Co., suppliers of the 4-D Wrought Iron pipe used on the return lines.

This is one of 11 Stickle differential boiler return systems at General Electric's famous Appliance Park in Louisville. For seven years, it's been pumping condensate back to a receiver tank in the boiler room at 270° to 280° F.—from heating and processing units as far as a mile away! The two pumps handle up to 150,000 lbs. of condensate per hour. Result: Tremendous savings in fuel and steam, plus top performance by all steam-using equipment.

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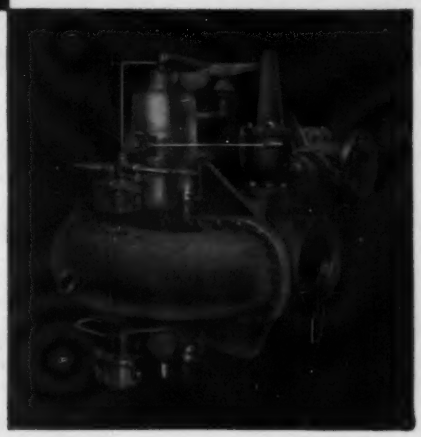

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Begins on page 202

**Oct 6-8 — National Association of Corrosion Engineers,** Southeast Region Conference, Dinkler-Plaza Hotel, Atlanta, Georgia. Details: T J Hull, 1061 M&M Building, Houston 2, Texas

**Oct 9-12—American Society of Mechanical Engineers,** Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa. Details: ASME, 29 W 39 St, New York 18, N. Y.

**Oct 9-13 — Electrochemical Society, Inc,** Meeting, Shamrock Hotel, Houston, Texas. Details: ECS, 1860 Broadway, New York 23, N. Y.

**Oct 11-14—National Association of Corrosion Engineers,** Northeast Region Conference, Prichard Hotel, Huntington, W. Va. Details: T J Hull, 1061 M&M Building, Houston 2, Texas

**Oct 12-14 — Industrial Management Society,** 9th Annual Methods Improvement Contest, 24th Annual Industrial Engineering and Management Clinic, Conrad Hilton Hotel, Chicago, Ill. Details: IMS, 330 S Wells St, Chicago 6, Ill.

**Oct 17-19—American Society of Lubrication Engineers,** 7th Conference, Statler Hotel, Boston, Mass. Details: ASLE, 84 E Randolph St, Chicago 1, Ill.

**Oct 17-21 — The Metallurgical Society,** Fall Meeting, Sheraton Hotel, Philadelphia, Pa. Details: AIME, 29 W 39th St, N. Y. 18, N. Y.

**Oct 19-20—National Association of Corrosion Engineers,** North Central Region Conference, Schroeder Hotel, Milwaukee, Wis. Details: T J Hull, 1061 M&M Building, Houston 2, Texas

**Oct 25-28—National Association of Corrosion Engineers,** South Central Region Conference, Mayo Hotel, Tulsa, Okla. Details: T J Hull, 1061 M&M Building, Houston 2, Texas

continued

# *How many spare parts should you stock per pump?*

"You may be *over*stocking," says Phil Olmstead, *Chief Engineer*, Goulds Pumps, Inc.

"There are many times," one plant manager told me recently, "when we have a *higher* inventory of spare parts than the people we buy from!"

No laughing matter, this—many plants today are faced with the difficult problem of keeping stocks *adequate*, yet keeping inventories *down*. If your problem is *pump parts*, you can do both—by *interchangeability!*

For instance, take the Goulds Fig. 3405 single-stage centrifugal. You can get it in 33 sizes, with 66 combinations possible, considering right- and left-hand rotation.

*Just 3 groups of parts fit all 66 combinations of this pump!*

That means that, for every three to five pumps of a given group size (sizes are divided up three ways into "small," "medium," and "large" groups), we can recommend that you stock just one shaft, one set of bearings, sleeves, mechanical seals or packing. *In short, all parts are interchangeable except casings, casing covers and impellers!*

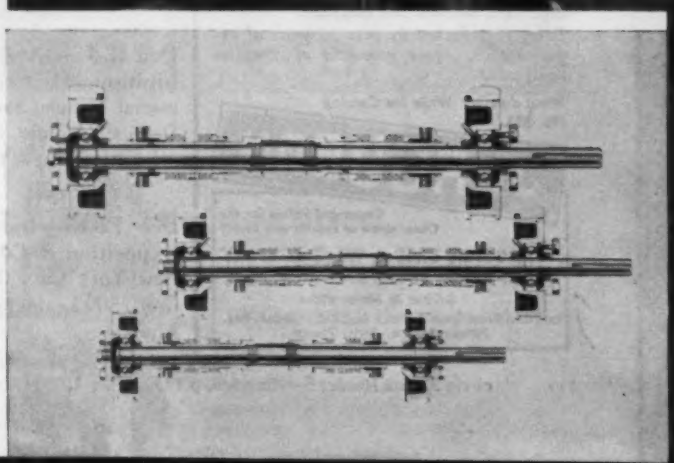
How much can that cut down your inventories? You figure it out—*one* set of group parts for as many as *five* pumps, where you might expect to stock one for each. *Three* groups for *thirty-three* different sizes of pumps—a *91% cutdown!*

And here are three more advantages to consider:

1. You can make changes *in the field* to meet new needs.
2. You receive off-the-shelf delivery of parts you order.
3. Initial cost is lower due to standardization in manufacture.

The next time you talk to a Goulds representative, ask him to show you how interchangeability works in our Fig. 3405 . . . and in the rest of our line, too. If you want information right away, drop a line to me, Phil Olmstead, at Goulds Pumps, Inc., c/o Dept. PO-60, Seneca Falls, N.Y. I'll see that you get all the information you want.

**GOULDS PUMPS**



Just three groups of shafts, sleeves, bushings, glands, packing, ball bearings, bearing shell, end caps, closures and gaskets for Goulds Fig. 3405 pump to fit all 33 pump sizes.

**For more facts circle 335 on Reader Service card, p 103**

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**Complete line** — wide range of sizes, pressures, hook-ups, materials.

**Reflex or Transparent** — *Reflex* for pressures up to 4000 lbs. @ 100° F. *Transparent* for pressures up to 20,000 psi test.

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**Choice of Materials** — stainless, monel, nickel, hastelloy, etc. Rubber, neoprene, lead, teflon, Kel-F and other linings. Meet or exceed AISI, ASTM and/or API-ASME requirements.

**Specials** — include non-frosting, large chamber, heated, welding pad, remote reading, lined, inclined and magnetic.

*Every gage backed by over 50 years of experience . . . your guarantee of complete satisfaction.*

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*Offices in Major Cities*
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Pétrole Service, Paris, France

## Calendar

Begins on page 202

**Oct 26-27—Computer Applications Symposium,** sponsored by Armour Research Foundation of Illinois Institute of Technology, Morrison Hotel, Chicago, Ill. Details: A Ungar, Armour Research Foundation, 10 W 35 St., Chicago 16, Ill.

**Oct 31-Nov 2 — Instrument Society of America,** 13th Annual Conference on Electrical Techniques in Medicine and Biology, sponsored by ISA, IRE, AIEE, Sheraton Park Hotel, Wash., D.C. Details: Director of Tech & Educ Services, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

**Nov 27-Dec 2 — American Society of Mechanical Engineers,** Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y. Details: ASME, 29 W 39 St, New York 18, N. Y.

**Nov 28-Dec 2—24th National Exposition of Power & Mechanical Engineering,** Coliseum, New York City. Details: E K Stevens, International Exposition Co, 480 Lexington Ave, New York 17, N. Y.

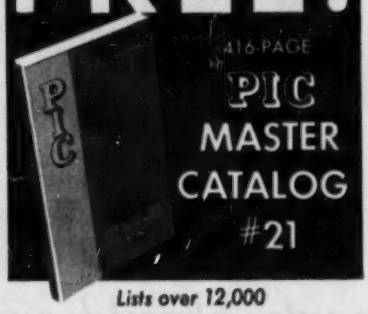
**Nov 30-Dec 2—American Institute of Mining, Metallurgical and Petroleum Engineers,** Electric Furnace Conference, Morrison Hotel, Chicago, Ill. Details: AIME, 29 W 39th St, N. Y. 18, N. Y.

**Dec 4-7—American Institute of Chemical Engineers,** Winter Meeting, Statler Hotel, Washington, D.C. Details, AICHE, 25 W 45th St, New York 36, N. Y.

**Dec 12-15—Atomic Industry Exhibition,** California Masonic Memorial Temple, San Francisco, Calif. Details: Atomic Industrial Forum, 3 E 54th St, New York 22, N. Y.

**Dec 12-15—Industrial Building Exposition & Congress,** Coliseum, New York City. Details: Banner & Greif, 369 Lexington Ave., New York 17, N. Y.

FREE!

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SAVE TIME
WITH KAMLOK QUICK COUPLERS

**CUT YOUR MAINTENANCE COSTS**

Save production time by replacing hose and pipe connections with Kamlok Quick Couplers. Used wherever hose and pipe connections are periodically uncoupled. Fast . . . Safe . . . Sure. No tools needed. Just fit together and pull the cam arms down. Lock securely in place. Leakproof gasket cannot fall out. All Kamloks 100% master gauged for complete interchangeability.

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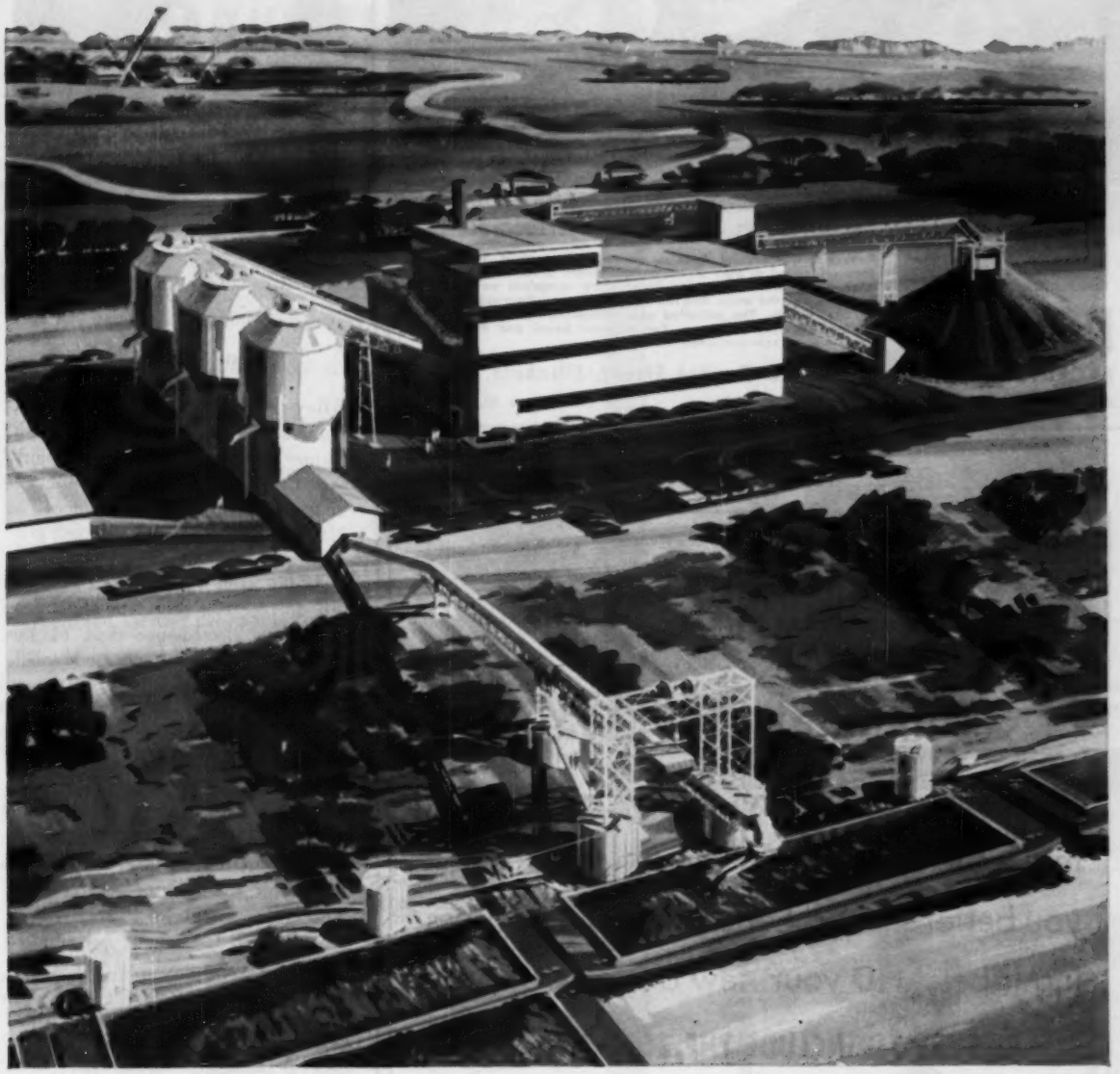
# BANNER MINE



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Robvon's Commercial Backing Rings are designed for quick easy alignment of pipe or tubing and assure precise close tolerance fit-up. Robvon Backing Rings allow complete penetration and fusion of the weld. Robvon Backing Rings radiograph perfect certified welds. The patented nubs automatically set the welding gap for the root-pass. The internal bevel and flat inner land assures non-restricted fluid flow.

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BE SURE TO INCLUDE THE ZONE NUMBER

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Fulfillment Manager
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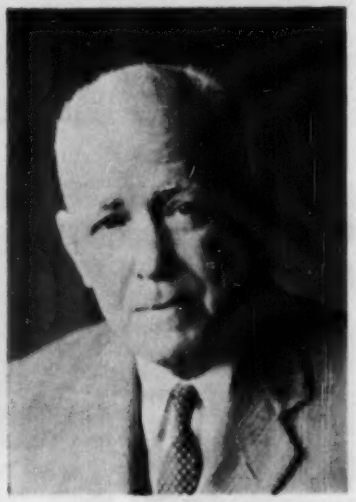
# Appointments

## Management changes



**Louis E Griffith**

**Riley Stoker Corporation** stockholders have elected Louis E Griffith, former president of the company, board chairman. Elected at the annual meeting of stockholders in March, Griffith was also renamed general manager and vice-president.

At the same time, Robert K Griffith, former vice-president and treasurer, was elected president of the corporation. Alexander L Mitchell was appointed a vice-president.

**Albert Kahn Associated Architects and Engineers, Inc:** S Saulson, director of mechanical engineering; G S Whittaker, chief of Mechanical Div. **Allis-Chalmers Mfg Co:** D B Scott, manager of control dept. **American Electric Power Service Corp:** D C Cook, H A Kammer, H Turner — board of directors. **American Electronics, Inc:** S Burns, director of engineering, Ground Support Div; W F Pease, general manager, Nuclear Div.

**American Pulley Co:** C E Bain, vice-president and general works manager. **Arthur D Little, Inc:** Lt Gen J M Gavin, president. **North American Aviation, Inc:** Dr C Starr, president and general manager of Atomics International Div. **Chase Brass & Copper Co, Inc:** H H Kremer, director. **C O Bartlett &**

# REPUBLIC VECTOR CONTROLLERS FEATURE 2 TO 500% PROPORTIONAL BAND ADJUSTMENT

Rockwell-Built Republic vector controllers feature easy proportional band adjustment from 2 to 500%, an adjustable reset rate from 0.1 to 50 repeats per minute and less than 0.05% dead band.

This is typical of the performance of Republic's new Null-Balance-Vector line of pneumatic instruments which includes:

- Temperature transmitters with a 10 to 1 range adjustment.
- Pressure transmitters of 0.5% accuracy, 0.1% sensitivity.
- Differential preasure transmitters with a 20 to 1 range adjustment.
- Relays which extract square root down to 10% of output span.
- Multiplying, squaring, additive, totalizing, and ratio relays.
- Other instruments necessary for measuring, controlling, and computing variables for combustion and process industries.

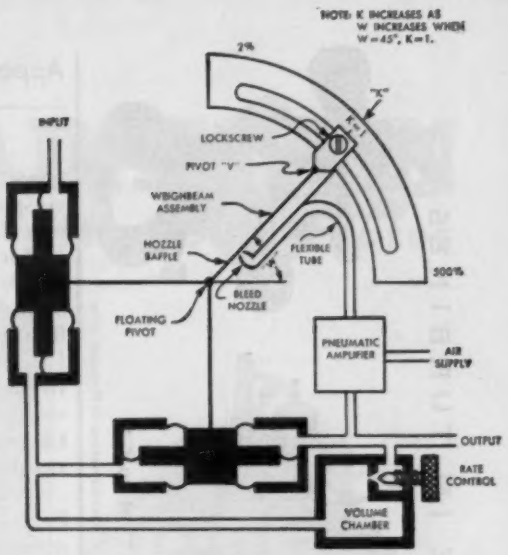
The span ("K") of each Republic Null-Balance-Vector instrument can be easily varied by loosening the lock-screw and sliding the weighbeam assembly along the slot as shown in the schematic. Zero does not have to be reset and only a comparison reference is required.

A common component, containing the "K" adjustment as illustrated, is the base around which each Republic Null-Balance-Vector instrument is built. This common "heart" means that you have interchangeability of parts—even among instruments performing different functions. Conversion and replacement parts can be pooled instead of stocking spare instruments for each control function.

In addition, you benefit from simplified operating and maintenance training because the same principle of operation is used for all instruments. All Republic Vector instruments are compact, lightweight and rugged. The Republic Engineer in your area will be glad to work with you on any control or measurement application. Or, write for information to Republic Flow Meters Company, Subsidiary of Rockwell Manufacturing Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada Ltd., Toronto.

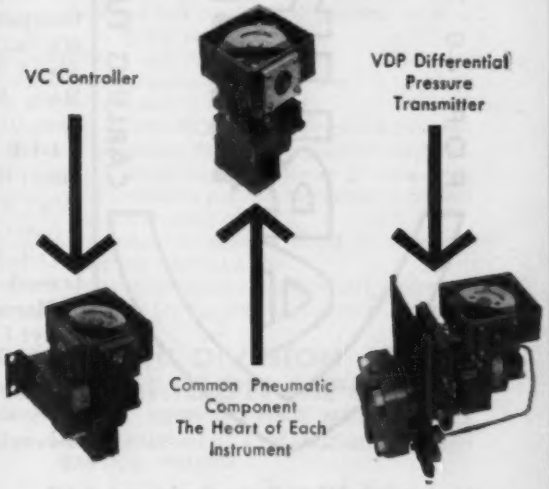
REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

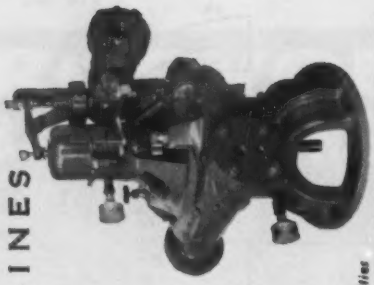
For more facts circle 340 on Reader Service card, p 103

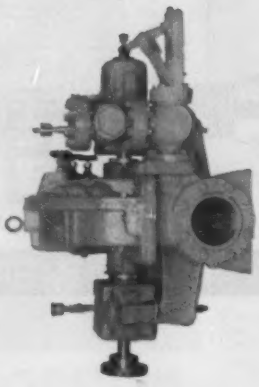


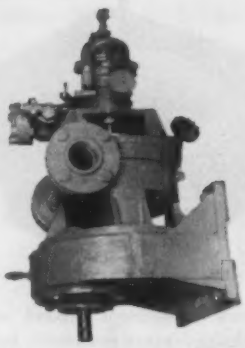
This is the common component around which each Republic Null-Balance-Vector pneumatic instrument is built. This component contains the "K" adjustment.

**TYPICAL REPUBLIC NULL-BALANCE-VECTOR INSTRUMENTS**









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CARLING TURBINES


## Appointments

Begins on page 212

**Snow Co:** C J Neville, executive vice-president; H S Hersey, chairman of board.

**Borg-Warner Corp:** A J Welch, president and general manager of Spring Div. **Burroughs Corp:** J B Rice Jr, director of manufacturing for ElectroData Div. **Calumet & Hecla, Inc:** D W Blend, director and vice-president of operations. **Coastal Chemical Co, Inc:** G C Paulsen Jr, vice-president and technical director.

**Cooper-Bessemer Corp:** F L Friedli, manager; R D Hamilton, assistant manager — En-Tronic Controls Div. **Dayton Rubber Co:** R D Rosenberg, vice-president in charge of international operations. **Dollinger Corp:** J J Hart, chief engineer, E G Pike, research director. **Engineers, Inc:** F C Winter Jr, assistant to vice-president of contract administration and client relations.

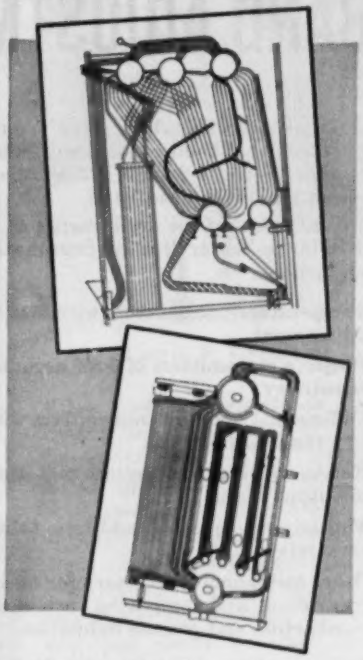
**Endevco Corp:** S Marks, manager of Endevco Ltd, London. **Everlasting Valve Co:** W Harrower, chairman of board. **Foster Wheeler Corp:** E F Wentworth Jr, F M Pyzel —vice-presidents. **General Electric Company:** H P Sisk, general manager of Distribution Transformer Dept; Dr J M Witzel, manager of engineering of insulating materials dept; J F Young, general manager of electric utility systems engineering and planning operation; Dr J H Hollomon, general manager of general engineering laboratory.

**Great Northern Oil Company:** F T Grassy, vice-president. **Hewitt-Robins, Inc:** E J Mytlowicz, vice-president in charge of operations for Hewitt Rubber Div. **H K Porter Company, Inc:** C R Billman, general manager of National Electric Div; F W Elliott, J A Drain, E M Mann, B Blake — group vice-presidents.

**I-T-E Circuit Breaker Company:** H L Buck, executive vice-president; A E MacKenzie, vice-president —power equipment. **Chas T Main, Inc:** C M Flint, V C M Hare, W J Lessard—directors.

**Marcus Transformer Company:** L Newler, board of directors. **Martin Company:** Dr W L Whitson, director of advanced programs; Dr A C Hall, director of research and engineering. **Metal & Thermit**


ONLY ENCO BAFFLES give you all these COST CUTTING FEATURES



These important fuel-saving maintenance-reducing features are obtainable with Enco boiler baffles—*and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottlenecks**
- **Reduced draft losses**
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- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.

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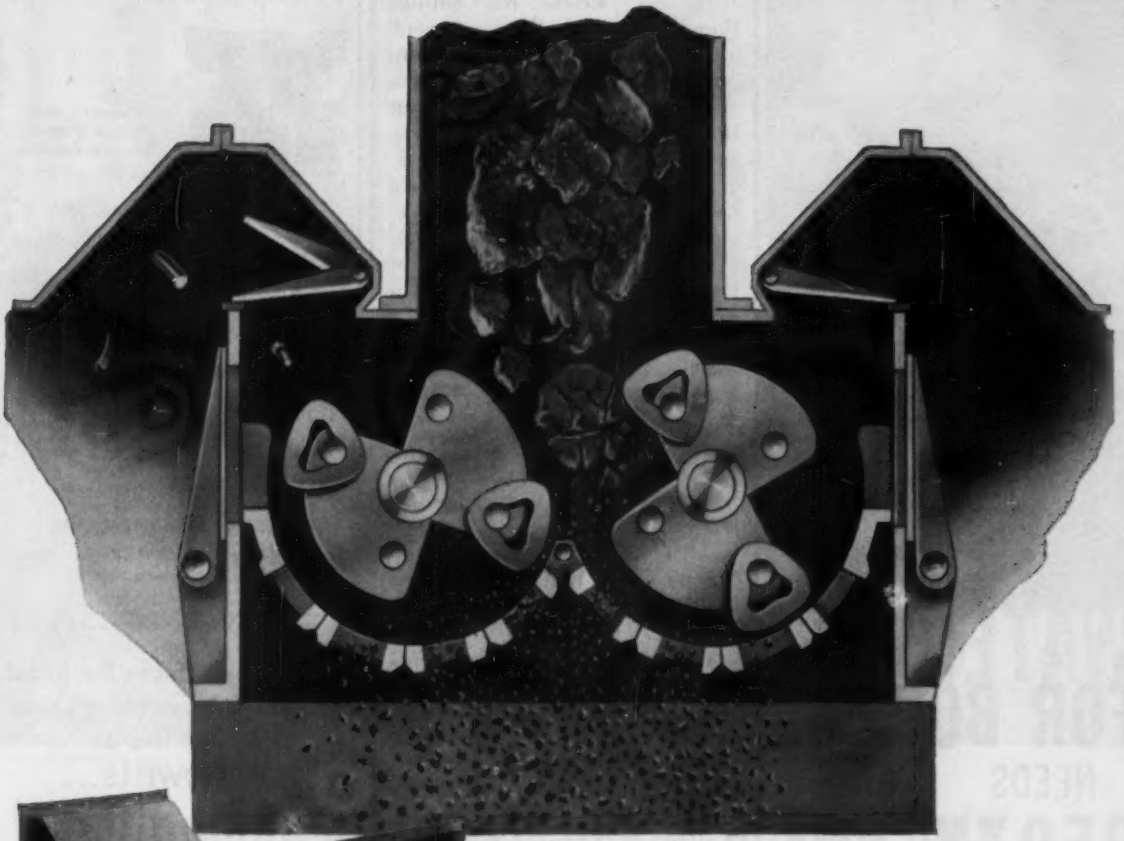
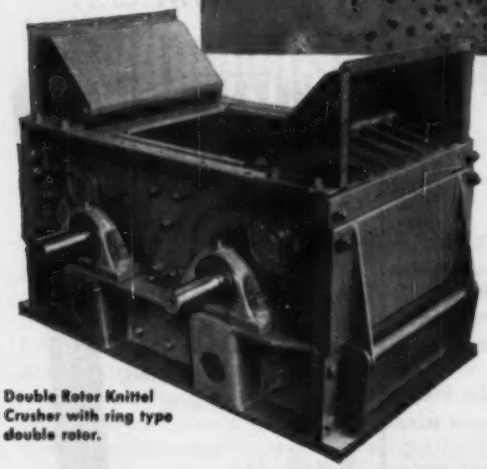
# STEPHENS-ADAMSON

## KNITTEL CRUSHER Ring Type with Double Rotor





Double Rotor Knittel Crusher with ring type double rotor.

### DOUBLE ROTORS BLAST LUMPS TO SIZE WITHOUT DANGER OF PLUGGING

- EXCLUSIVE CRUSHING ACTION . . . Permits the material to fall further into the crusher where two sets of triangular sectors can take a high velocity direct blow on the suspended lumps. Lumps are not only shattered but are literally gobbled up in a continuous flowing stream to the sizing grates.
- CRUSHES DAMP MATERIALS with FULL CAPACITY . . . Eliminates the use of stationary breaker plates, as a result there is no plugging or choking and full capacity is maintained.
- LESS HEADROOM — LESS POWER REQUIRED . . . Requiring considerably less headroom and less power than with single rotor machines.
- TRIANGULAR SECTORS . . . Three wearing surfaces of manganese steel triangular sectors automatically position themselves to present the least worn surface to the crushing action.
- GRATE SIZING BARS . . . Provide accurate sizing of materials, prevent uncrushable materials from passing.
- AUTOMATIC TRAMP IRON RELEASE . . . Steel fingers, operating independently, automatically lift to pass uncrushable material.

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S-A

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SPEEDWAY® PASSENGER CONVEYORS

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**ENGINEERING DIVISION**

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WATER FOR BOILERS NEEDS DEOXY-SOL

- to remove $O_2$
- reduce oxides
- raise pH

Fairmount DEOXY-SOL, a solution of hydrazine, is a high efficiency oxygen scavenger designed especially for high pressure boiler water treatment.

DEOXY-SOL removes oxygen, reduces oxides and raises pH of the condensate all at the same time . . . yet adds no solids.

Stocks in Newark, N. J., Chicago, Ill., Los Angeles, Calif. Investigate its advantages for your system. Write for Bulletin BW.

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## Appointments

Begins on page 212

**Corp:** R T Brown, manager of Welding Div. **Milton Roy Co:** J P Hogan, board of directors.

**Narmco Resins & Coatings Company:** J C Profita, general manager. **The Ohio Injector Company:** B J Milleville, vice-president of engineering and research. **Norton International, Inc:** Dr W F L Place, vice-president and general manager.

**Pacific Coast Engineering Company:** G Embry, industrial engineering manager. **Pall Corp:** Dr M P L Siebel, general manager of Pressure Equipment Div. **Perkin Engineering Corp:** J H G Maters, executive vice-president in charge of manufacturing. **Research-Cottrell, Inc:** J W Hinkley, president; A B Walker, assistant director of research and development.

**Sylvania Electric Products, Inc:** W K Anderson, manager of equipment development for Sylvania Lighting Products Div. **Symington Wayne Corp:** R A Knaus, general manager of Wayne Pump Co Div, Fort Wayne Operations; N L Harms, vice-president. **United Engineers and Constructors, Inc:** J T Pinkston, vice-president; R R Wagstaff, engineering vice-president and director. **Union Carbide Corp:** J C Brantley, director of research for Union Carbide Nuclear Company. **Wallace & Tiernan, Inc:** H W Tripp, director.

## Consultant changes

### Alvin M Weinberg

**Oak Ridge National Laboratory** director, Alvin M Weinberg, will serve with a 21-man team on the Science Advisory Committee in Washington. He was appointed by President Eisenhower in March for a term extending to December 31, 1962. Committee advises the President in matters relating to science and technology.

Weinberg received BS, MS and PhD degrees from the University of Chicago and worked there in biophysics research from 1939 to 1942. He entered atomic-energy work the day after Pearl Harbor. With Pro-


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THERMOSTATIC STEAM TRAPS

pressures from Vacuum to 250 lbs.
Semi-steel Construction
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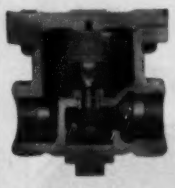
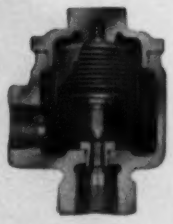


TYPE B-250

pressures from Vacuum to 200 lbs.
Bronze Construction
½", ¾", 1"



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TRINITY announces the latest addition to the industry's most complete line of THERMOWELLS... the

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A complete line of low-cost, high-quality thermowells for thermocouples, bi-metallic, thermometers, and test instruments.

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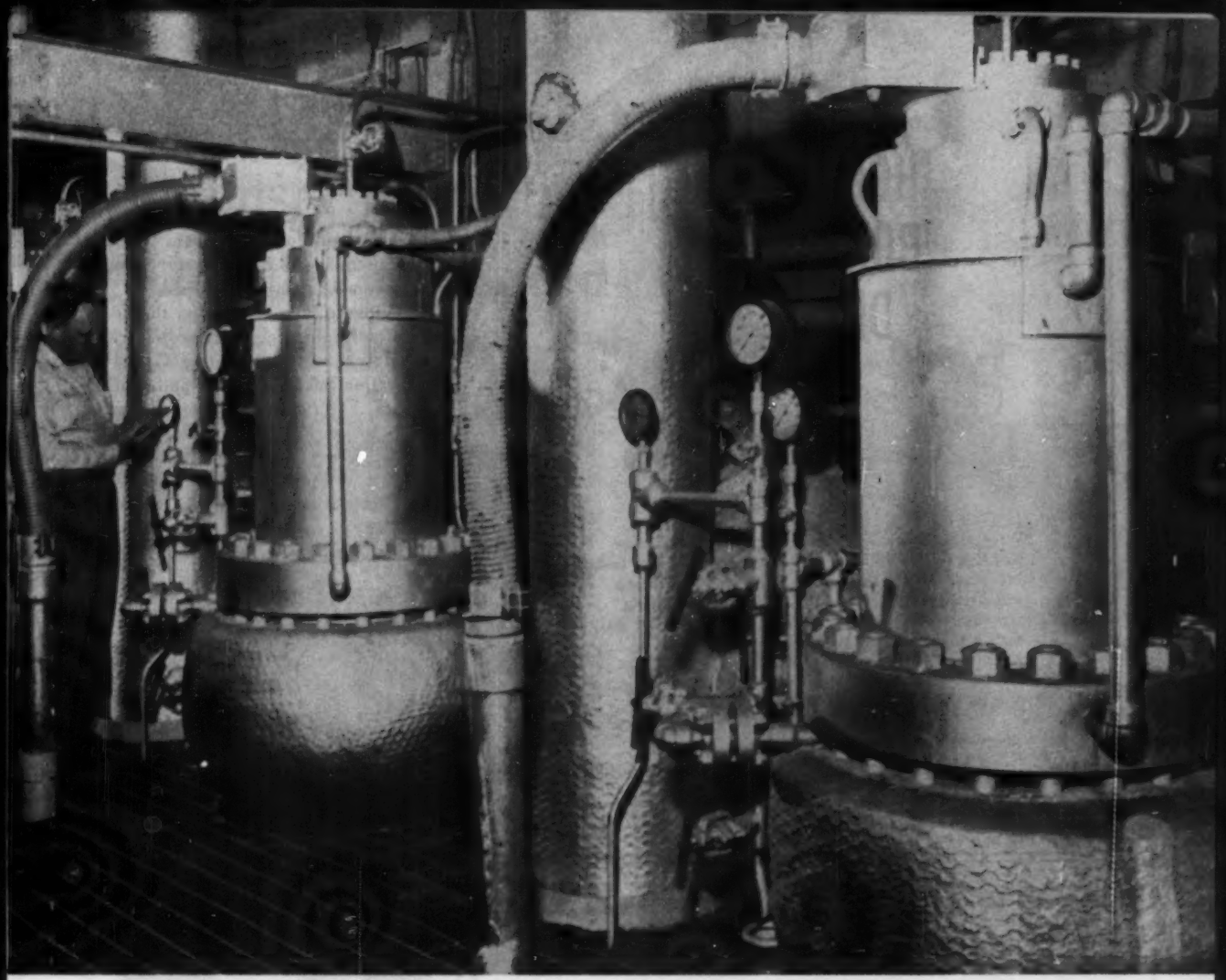


"Canned" motor-pumps at 275-mw McMeekin station operate at 6270 gpm, 652°F with suction pressure of 2536 pounds.

# Westinghouse canned motor-pumps help McMeekin station post nation's best heat rate

South Carolina Electric and Gas Company's Silas McMeekin station* recently recorded an annual heat rate of *9093 Btu* per net kwhr. This is the *number one* efficiency rating for the whole country in the Federal Power Commission's latest "Steam-Electric Plant Annual Production Expenses" report.

With two Combustion Engineering Controlled Circulation boilers furnishing the entire steam supply, the three Westinghouse "canned" motor-pumps installed on each boiler were important factors in this plant's exceptional efficiency rate.

- In operation since the second quarter of 1958, no pump has had to be opened for inspection or repair.
- The pump and motor casings completely enclose the pump shafting . . . eliminating conventional shaft seals and power-consuming seal injection systems.
- Watertight Inconel can encases stator . . . windings are dry and clean for years of trouble-free operation.
- Water lubricated bearings show maximum reliability and minimum wear characteristics.

To learn how Westinghouse "canned" motor-pumps will improve efficiency of *your* Controlled Circulation boiler, call your Westinghouse sales engineer, or write Westinghouse Electric Corporation, Atomic Equipment Department, P.O. Box 217, Cheswick, Pa. J-57023-R

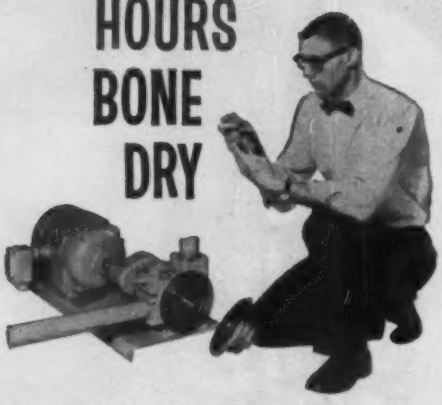
*Gilbert Associates, Consulting-Engineers

YOU CAN BE SURE...IF IT'S Westinghouse

TUNE IN WESTINGHOUSE-CBS TV-RADIO COVERAGE, PRESIDENTIAL CONVENTIONS, JULY 10-29

For more facts circle 346 on Reader Service card, p 103

# 2000 HOURS BONE DRY



When asked how well our pumps would wear, we had this to tell. In one of the toughest pumping tests ever devised, a 2-inch Blackmer vane-type pump was driven at top speed for 2000 hours, running absolutely bone dry. Vane wear was detectable only with a micrometer! Even when vanes do show wear, they are inexpensively replaced. Aren't these good reasons why you should specify Blackmer pumps? Write for Bulletin One.

"liquid materials handling"® equipment

**BLACKMER** / *rotary pumps*

BLACKMER PUMP COMPANY, GRAND RAPIDS 9, MICHIGAN

*Find your Blackmer Man under "Pumps" in the Yellow Pages*

**For more facts circle 347 on Reader Service card, p 103**



## POWER's *FUEL FACTS*

**Containing these famous Power Special Sections:**

FUELS AND FIRING

FUEL HANDLING AND STORAGE

**PLUS Two big extras:**

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CLEAN AIR: THE ENGINEER'S WAY

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Name (Please print or type) _____

Street Address _____

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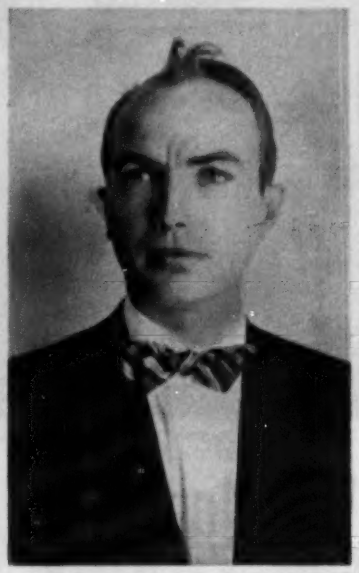
*Deduct 10% on orders of 10 or more.


## Appointments

Begins on page 212

fessor Carl Eckhart he began work on neutron-diffusion problems which were similar to diffusion problems he encountered in biophysics.

Weinberg later worked on the design of Hanford chain reactors, primarily on problems relating to multiplication factor. He is co-author of a book, *The Physical Theory of Neutron Chain Reactors*, published in 1958. Weinberg was a member of the 6-man scientific team which visited nuclear-energy installations in the U.S.S.R. last fall. He is president of the American Nuclear Society.



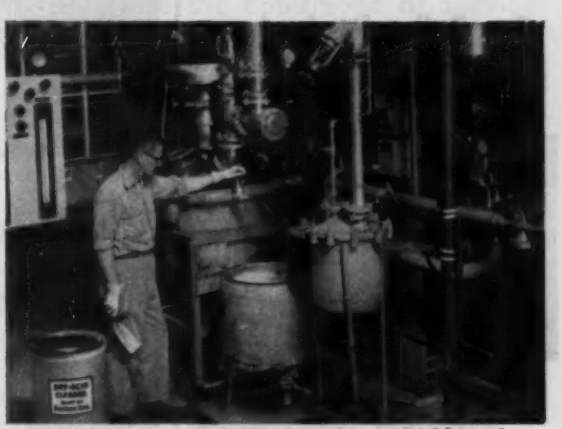
**Dr Frank E Swatek**

**American Laboratories Div** of American Electronics, Inc has filled a newly created staff-consultant position with one of the leading fungus experts on the West Coast, Dr Frank E Swatek. He will deal with actual and potential problems in antifungus design in electronic, missile and space applications. His services will extend to all divisions of American Electronics, Inc.

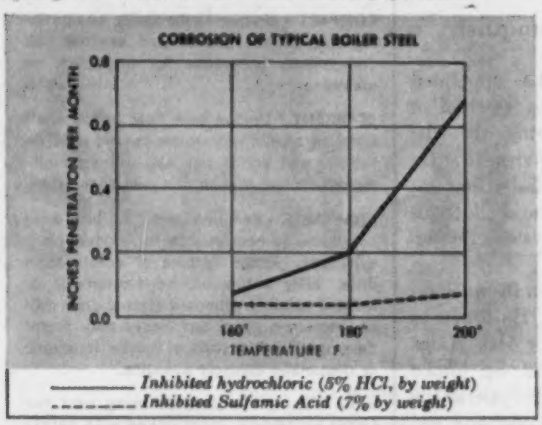
He has been a consultant with Hallimore Electronics Div of Siegler Corp and Rocketdyne Div of North American Aviation, Inc. He is a member of American Men of Science and the New York Academy of Science. In addition to his new post, Dr Swatek is professor of microbi-

# Descale boilers, heat exchangers, condensers rapidly, thoroughly with safer **dry acid** cleaners based on **Du Pont Sulfamic Acid**

**SAFER TO HANDLE.** Just pour dry acid cleaner based on Du Pont Sulfamic Acid from easy-to-handle, fiber drum into make-up tank. No danger from broken bottles, liquid spillage or corrosive fumes with these dry powders.



**EASIER TO USE.** Simply pump cleaning solution from make-up tank into boiler. Often dry acid cleaners can be added directly to equipment being cleaned. No elaborate equipment or specially trained labor needed.




**LESS CORROSIVE.** Sulfamic cleaners approach the strength of hydrochloric acid, yet are far less corrosive. Excellent inhibitor stability allows their use at higher temperatures for faster scale removal.

**NON-FUMING.** Sulfamic cleaners produce no corrosive fumes, either dry or in solution. Corrosion in vapor spaces of equipment during cleaning operation is eliminated, along with fume nuisance to personnel.

**Ask your supplier for safer, effective cleaners based on Du Pont Sulfamic Acid, or mail coupon for additional information and names of formulators who offer these compounds.**

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING ... THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.)
Industrial & Biochemicals Dept., N-2533P
Wilmington 98, Delaware

Please send me ☐ sulfamic acid general equipment cleaning bulletin; ☐ names of formulators offering cleaners based on sulfamic acid.

*Name*_____

*Company*_____

*Address*_____

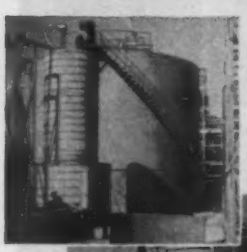
*City*_____ *State*_____



For more facts circle 348 on Reader Service card, p 103

# WHO CHOSE H&T ?

## For Boiler Feedwater Conditioning Equipment



400,000 lb. per hour fully automatic demineralizer plant with silica and $CO_2$ removal

**These Fine Companies Did!**

*A Partial List of Installations*

**Duquesne Light Co.**
Shippingport, Pa.

**Yankee Atomic Electric Plant**
Rowe, Mass.

**Ohio-Edison Co.**
Akron, Ohio

**Bowaters-Carolina Corp.**
Catawba, S.C.

**Knolls Atomic Power Laboratory**
West Milton, N. Y.

**The Cleveland Elec. Illuminating Co.**
Ashtabula, Ohio

**Chevrolet Div. Gen. Motors Corp.**
Tarrytown, N. Y.

**R. J. Reynolds Tobacco Co.**
Stokes County, N. C.

**Tampa Electric Co.**
Tampa, Florida

**U. S. Gypsum Co.**
Chicago, Ill.

*Send for new Bulletin*
*50 Years of Progress*

**HUNGERFORD & TERRY, Inc.**
CLAYTON 3 — NEW JERSEY
H&T SERVICE


## Appointments

Begins on page 212

ology at Long Beach State College. He received his degrees from San Diego State College and UCLA.

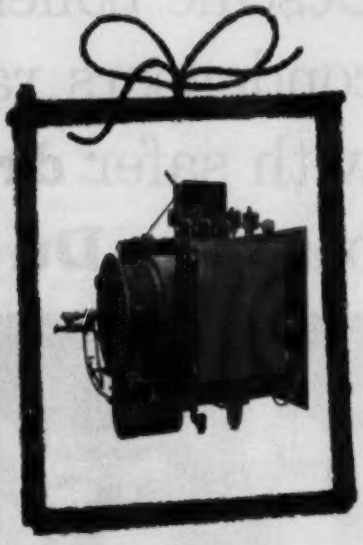
### Engineer changes

**Walter K Stromquist**

**Alco Products, Inc** has appointed Dr Walter K Stromquist as chief of plant-systems engineering in the power-engineering department. He will be responsible for design of components and instrumentation for primary and secondary systems in nuclear-power plants.

Stromquist has been in the nuclear-power field since 1946. He began as a chemical engineer for Oak Ridge National Lab. In 1952 he joined AEC's Savannah River operations office as a chemical engineer and was later associated with E I du Pont de Nemours at Savannah River. At Westinghouse Electric Corporation's atomic-power department he supervised the reactor-systems section. He received bachelor and doctorate degrees from the University of Tenn.

**Allis-Chalmers Mfg Company,** Power Equipment Div: R F Alsworth, motor and generator dept; R E Birner, P Cain—steam turbine dept; N P Grimm, G C Kutsch, R W Schlicht, W J Severson—nuclear power dept; J W Adam, R E Kiel,

**NEW . . . FABER'S COMPACT PACKAGE OIL-GAS-OR COMBINATION BURNER**

Faber's rugged new "AF" Packaged Burner—field tested over 5 years' continuous duty—offers these advantages:

**COMPACT** • Unique space-saving design integrates burner, blower and controls. All components accessible for inspection or maintenance.

**EFFICIENT** • Unique axial flow, hollow shaft forced draft fan, adjustable curved vane air register and Voltrol fan inlet vanes for efficient turbulent fuel-air mix over wide range.

**ADAPTABLE** • Fan unit and "V" belt drive adjustable to heavier load for modest plant expansion. Motor, turbine or combination drive. Fully automatic, semi-automatic or manual controls. Standard electric drive with oil immersed gears and heavy duty motor develops 100 ft pounds of torque. Hydraulic or pneumatic controls available.

**SAFE** • Complete programming unit for flame safeguard, interlocked with safety circuit.

Write for Faber Catalog 59-1:
**FABER ENGINEERING CO., Inc.**
240 West Washington Street,
Norristown, Penna.
or any handy Faber dealership

**FABER**
*ENGINEERING COMPANY, INC.*

**Manufacturers of** Industrial Oil and Gas Burners, Fuel Oil Pump and Heater Units, Special Pumping Units, Since 1927 F-197




circle 349 on Reader Service card, p 103

circle 350 on Reader Service card, p 103

# accuracy

**ASHCROFT DURAGAUGES** measure pressure with precise accuracy no matter how severe the conditions of service

*Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".*

# sustained

The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

***ASHCROFT PRESSURE GAUGES***

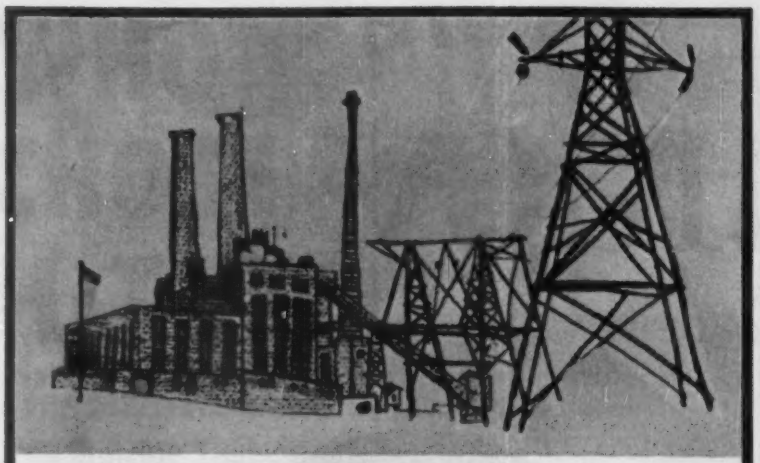
*A product of*

**MANNING, MAXWELL & MOORE, INC.**

*Gauge and Instrument Division • Stratford, Connecticut*
*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



For more facts circle 351 on Reader Service card. p 103



# TEXTILES BY U. S. RUBBER

## INSURE SAFER INSULATION!

Looking for top-quality insulation jacketing with high tensile strength, maximum durability? Specify modern, noncombustible ASBESTON® fabrics by U.S. Rubber, now used on heating, piping, refrigeration, air-conditioning systems. Wire, call or write Asbeston Department.

U.S. ROYAL TEXTILES SINEWS FOR INDUSTRY

US RUBBER

**Textile Division**

**United States Rubber**

Rockefeller Center, New York 20, N. Y.

**For more facts circle 352 on Reader Service card, p 103**

Babbitt

*Adjustable* SPROCKET RIM

*with Chain Guide*

Changes that Danger Zone to a

SAFETY ZONE

The distance between the floor of your plant and your overhead valves is a DANGER ZONE when piled up boxes or even ladders are used to reach the valves.
Turn it into a SAFETY ZONE — equip your overhead valves with Babbitt Adjustable Sprocket Rims with Chain Guides.

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. If your supplier does not carry them, contact us direct.

Babbitt STEAM SPECIALTY CO.

2 Babbitt Square, New Bedford, Mass., U.S.A.

**circle 353 on Reader Service card, p 103**

DESIGNED FOR STEAM TURBINE TESTING

TYPE WG DEAD WEIGHT PRESSURE GAGE

*Please request data sheet 593*

MANSFIELD & GREEN INC.

1051 POWER AVE.

CLEVELAND 14, OHIO

**circle 354 on Reader Service card, p 103**


## Appointments

*Begins on page 212*

engineering scientists in Research Div. **Brown Fintube Company:** J W Nevins, chief engineer. **General Electric Company,** Computer Dept: R A Daskam, L D Goldsmith, T H Lee—application engineers.

**Harbison-Walker Refractories Co:** C D Jamison, ceramic engineer. **H K Porter Company, Inc.,** Leschen Wire Rope Div: A J Abruzzo. **Magnetic Metals Company:** J E Longenecker, chief mechanical engineer. **American-Monarch Corp:** H T Mooers, R J Zelinka, D C Mogen. **Pall Corp:** C H Hacker, M Kurz, S Sakol, M Sankey. **Daystrom Inc,** Weston Instruments Div: A G Evans, chief engineer of research and development; P C Cornish, chief engineer of product development.

## Recent purchases and mergers

**American Chain & Cable Co, Inc:** purchase of Electro-Mech Corporation. **Dayton Rubber Company:** agreement to acquire Metal Hose and Tubing Company. **Hamilton-Thomas Corp:** acquisition of major interests in Griscom-Russell Co and Smart-Turner Machine Co, Ltd. **Information Systems, Inc:** acquisition of operating assets of Pancellit, Inc.

**Kollsman Instrument Corp:** acquisition of Richardson-Allen Corp. **Magnetic Amplifiers, Inc:** agreement to merge with Siegler Corp. **Symington Wayne Corp:** purchase of assets of Oil Equipment Div of Graver Tank & Manufacturing Co. **Texstar Corp:** merger with Air Accessories, Inc.

## New names

**Almasol Corp:** subsidiary of Lubrication Engineers, Inc to provide solutions for lubrication and protective-coating problems.

**Burns and Roe Western Hemisphere Corp:** wholly-owned subsidiary of Burns and Roe Inc, will engineer and construct projects in all the Americas except United States. **Canadian Timken Div of Timken Roller Bearing Company:** Timken Roller Bearing Company's manufacturing operations in Canada.

**continued**

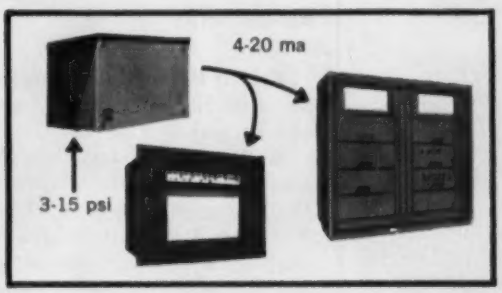
# Whether you're controlling or recording

## . . . now you can mix electric and pneumatic components

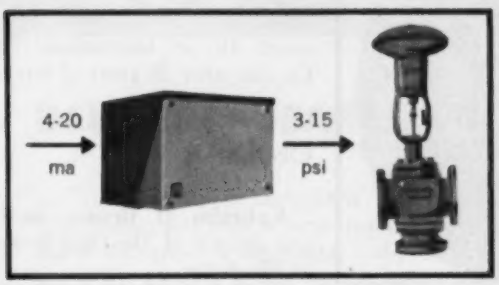
The introduction of Honeywell's complete line of *ElectriK Tel-O-Set* instruments makes electric and pneumatic components completely compatible.

Now you can add the advantages of electric instrumentation to your present *pneumatic* systems. Or, if you are designing a new system, you can use your favorite pneumatic components in an otherwise completely electric system.

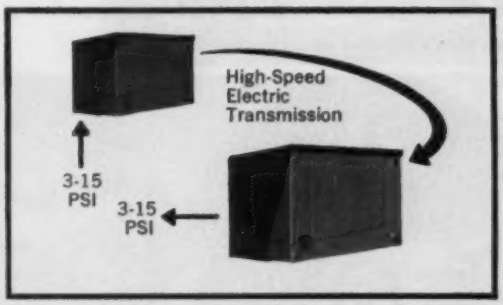
Here's an example: You have a pneumatic system but want to record a key variable on an *ElectroniK* strip chart recorder. The answer is an *ElectriK Tel-O-Set* pressure-to-current (P/I) transducer which converts the standard 3-15 psi signal to a standard 4-20 ma signal which can be fed to a data logger or computer as well as to a potentiometer.




Now let's assume that you are putting in an all-electric system but prefer pneumatic control valve operators. Here the answer is an easily installed *ElectriK Tel-O-Set* current-to-pressure (I/P) valve operator which converts the standard 4-20 ma signal to a standard 3-15 psi signal.




Used separately, *ElectriK Tel-O-Set* transducers allow you to easily intermix electric and pneumatic components. Used together, in pneumatic loops, they give you long distance high-speed transmission and eliminate the lags inherent in long runs of pneumatic tubing.




These twins have a calibrated accuracy of ± ¼% of span. They're completely transistorized for long, reliable service. Only two wires, forming a series circuit between the two transducers, are needed to carry the signal as well as the system's power. Line power is not required in the field.

Transducers are just part of the story. *ElectriK Tel-O-Set* transmitters are available to convert temperature, pressure, differential pressure, and other process variables into a current signal. To complete your system, you have a wide choice of different types of electric control . . . readouts including meters, indicators, and large case recorders . . . and final control elements.

Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne & Windrim Avenues, Phila. In Canada, Honeywell Controls Limited, Toronto 17, Ont.

**Honeywell**

First in Control

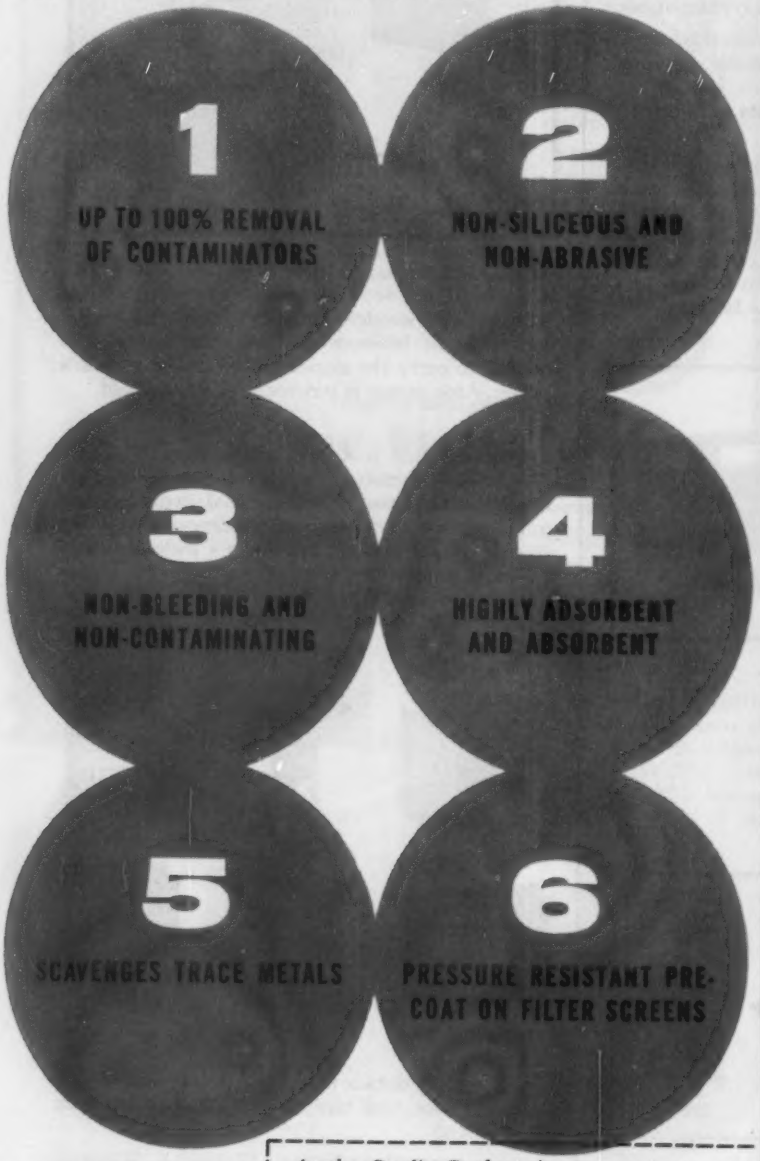
SINCE 1885

75th YEAR PIONEERING THE FUTURE

# SOLVE CONDENSATE CONTAMINATION

**with newest, super-efficient filter aid**

**SOLKA-FLOC®** High steam pressure condensate contamination is often a serious and trouble-causing problem. Solka-Floc, basically different than other filter aids, removes up to 100% of contaminators—metallic ions, suspended solids, emulsified oil. It provides effective and economical filtration.




Whether your operations are simple or complex—send for the important and complete story on SOLKA-FLOC.

*Another Quality Product of* FP6

BROWN COMPANY

150 Causeway Street, Boston 14, Mass.

Please send me your Solka-Floc folder.

COMPANY_____

NAME_____ TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____


## Appointments

Begins on page 212

**The Dayco Corporation:** change of corporate name of The Dayton Rubber Company.

**Electrical Apparatus Service Association, Inc (EASA):** former National Industrial Service Association, Inc (NISA). **Metachem Resins Corp:** new organization will serve industry with specialized chemical formulations in epoxy, polyester, and allied resins field. **Pressure Elements, Inc:** new company will design, manufacture and market pressure diaphragms and capsules. **Richardsons Westgarth Inc:** U.S. subsidiary of The Richardson Westgarth Group of Companies, British engineering group.

## Retirements

**R H L Becker,** managing director of Oil Heat Institute of America, after ten years.

**William J Healey,** New York sales engineer, Weston Instruments Div, Daystrom, Inc, after 45 years.

**Abbott L Penniman Jr,** Baltimore Gas and Electric Company vice-president of electric operations, after 49 years with the company.

**Albert D Sheere,** div manager for A M Byers, after more than 36 years of service.

**W L Thompson,** supplier-relations manager for Westinghouse Electric Corp, after 47 years.

**James S Vanick,** research metallurgist with Development and Research Div of International Nickel Co, Inc, after 38 years of service.

## Obituaries

**Ephraim H Brown,** secretary and director of The Ohio Brass Co, on March 23.

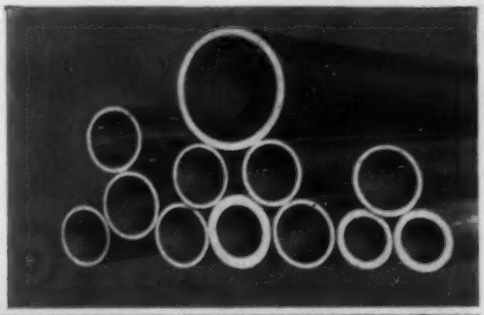
**James A Eccles,** director of the Shawinigan Water and Power Co, Quebec.

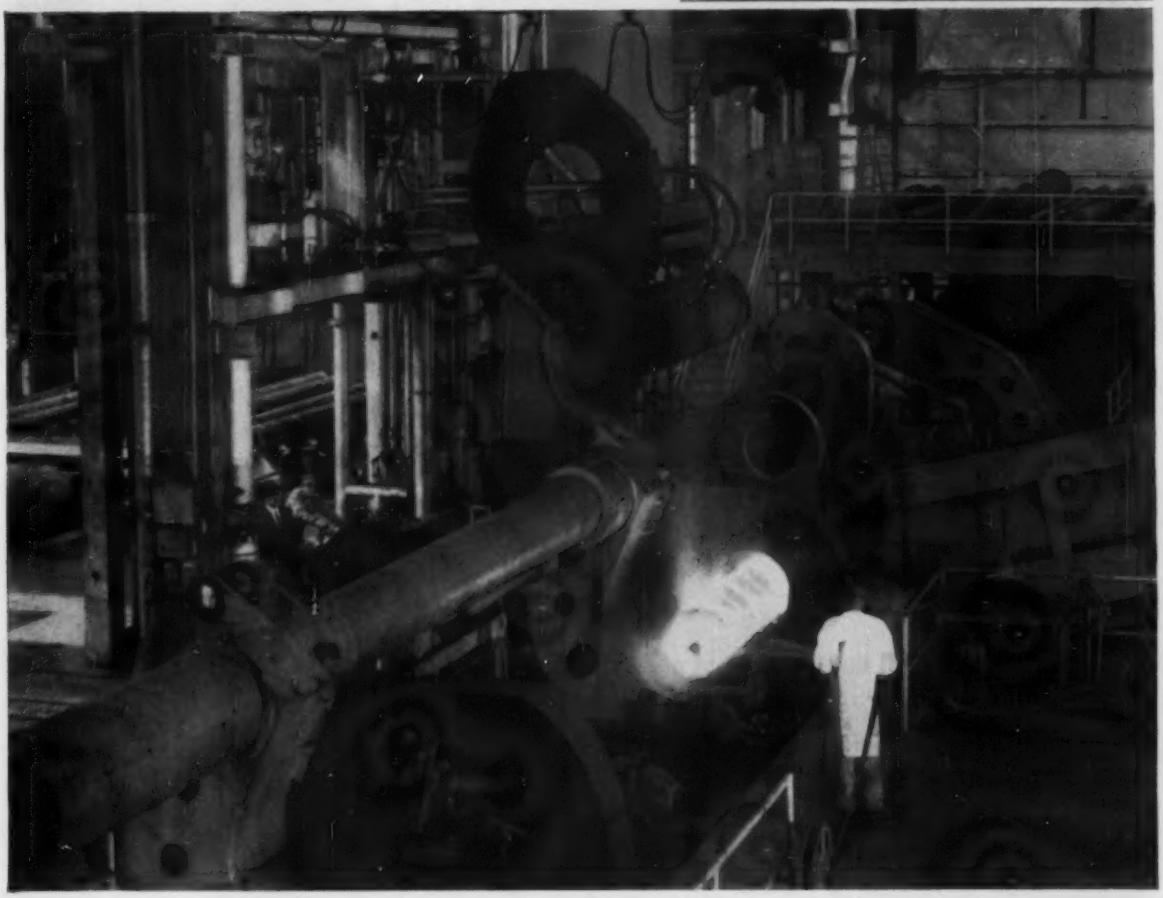
**Rupert H Gustafson,** former president of Sundstrand Engineering Co, on Feb 28.

**Charles T Young,** retired factory manager of Passaic plant, Raybestos-Manhattan, Inc, on April 2 at the age of 90.

continued

# WHAT DO YOU LOOK FOR IN FORGED HEAVY WALL PIPE?





## DELIVERY GEARED TO PRODUCTION SCHEDULES?

. . . Then you can buy from B&W with confidence. For whether you require large quantities or small, B&W deliveries are dependable and prompt.

B&W has added a second draw bench to the line for production to meet your needs *on time* with availability of a wide range of fractional sizes and a selected range of standard pipe sizes in carbon, intermediate chromium and stainless steels. B&W specializes in matching the pipe to your job requirements. Why not get the full details about high quality B&W Heavy Wall Forged Pipe! Just write for Bulletin S-16. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

S-484-HF

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION



For more facts circle 357 on Reader Service card, p 103

# BUELL CAME UP FAST ON THE OUTSIDE!

**In fly ash collection** the specification of electric precipitators is... increasingly... "Buell". The 1959 central station design survey published by POWER magazine in October, 1959 shows that Buell installed 8 out of 22 precipitators. And that high proportion was not surpassed even by the longest-established manufacturer in the field! ■ Why this fast-growing demand for Buell electric precipitators? There are many reasons. Unique design features minimize maintenance and provide exceptionally high efficiencies. In 10 years of selling Buell SF Electric Precipitators, the number of spare and replacement parts ordered from Buell has amounted to less than 2% of the total sales! You seldom replace Buell's exclusive 'Spiralectrodes,' because the rigid fastening makes sure they won't break. Their precise construction of strong-heavy stainless steel prevents rust and corrosion. ■ See for yourself some of the reasons why men in many industries are specifying Buell SF Electric Precipitators. Send now for details. The Buell Engineering Company, Inc., Dept. 50-F, 123 William St., New York 38, N.Y. Northern Blower Division, 6404 Barberton Ave., Cleveland, Ohio. (Subsidiary: Ambuco Ltd., London, England.)

buell Norblo


## Appointments

Begins on page 212

**R E Brooks**

**Cleaver - Brooks Company** co-founder R E Brooks, pioneer in establishing the packaged-boiler industry, died at the age of 77 in Milwaukee. He was board chairman of Cleaver-Brooks at the time of his death and had served as president from 1931 to 1943.

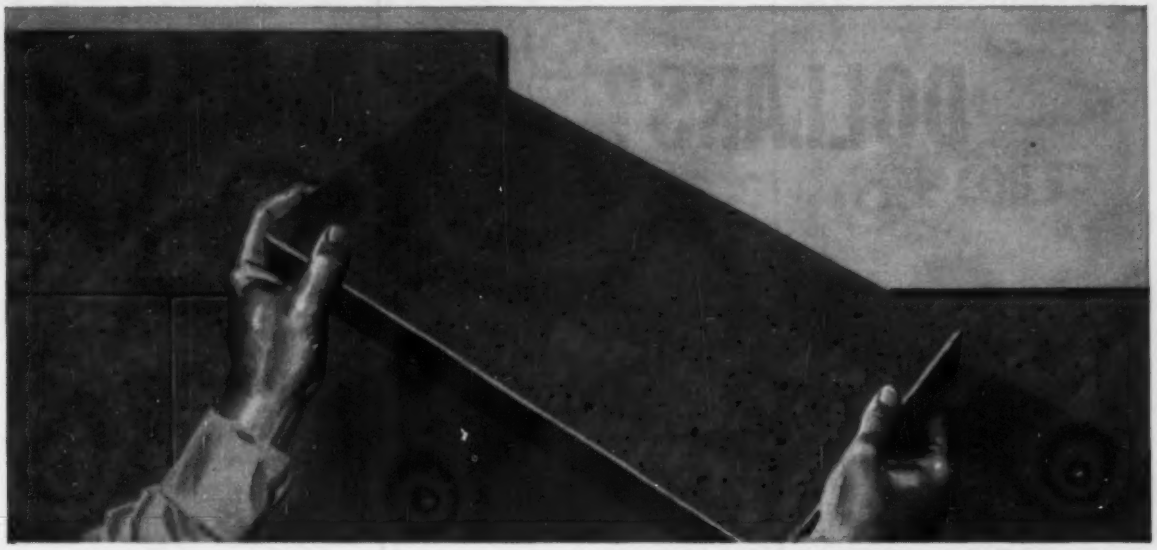
Mr Brooks teamed with J C Cleaver in 1931 to found the Cleaver-Brooks Company. A year later, with the installation of a tempoary portable boiler on a small Wisconsin dairy farm, they began a new industry. Today, Cleaver-Brooks is a leader in the packaged-boiler field.

Brooks attended Colgate University, where he was elected to Phi Beta Kappa. Beside his Cleaver-Brooks affiliations, he served industry as vice-president and sales manager of National Equipment Company, director of Koehring Co and founder of the R E Brooks Co, construction-distribution firm. Among his survivors is a son, J G Brooks, vice-president of Cleaver-Brooks.

---

**Volcanic steam** will be energy source of power station being erected in southern Kamtschatka, U.S.S.R. Vapor shafts directed to turbines are being dug at present. Kamtschatka is in the Baudjeka valley.

# A TRUE-CUT BLOCK WITH PRECISION-FINISH!



- Eagle-Picher's "precision-finish" is one of the most important insulation developments in years.
- Highly efficient, all-purpose block that is practically dustless.
- Great structural strength! Meets rigid demands for long-lasting block able to withstand wide temperature range up to 1900 F.
- Lightweight, easily installed! Easily cut to fit irregular areas—no special tools needed. Requires only minimum reinforcing.
- Effectively resists steam and other moisture! Does not disintegrate or lose thermal efficiency under heavy duty service.

## EAGLE-PICHER
# PV SUPERTEMP
## BLOCK INSULATION

*Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.*

*Since 1843*
The EAGLE-PICHER Company
Dept. P-660
Cincinnati 1, Ohio

EAGLE EP PICHER

# how many places in your plant does a 3-second power loss mean

# DANGER?

# DAMAGE?

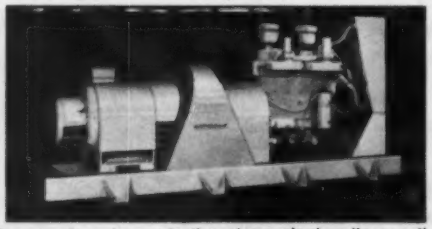
# DOLLARS?

**A certain film processor** faces both damage and loss of dollars in even short power failures. The material used in film coating begins to congeal in 3 seconds after power fails . . . the line must be torn down, production scrapped, equipment cleaned and the process begun again.

Food, drugs, petro-chemicals, textiles, data processing . . . all face the same danger, damage or dollars as the price of power loss.

**Power with absolutely no interruption**

Condec's UPS (Uninterrupted Power Supply) eliminates this problem completely because it provides power without interruption, full voltage restoration in 1.5 milliseconds. Frequency is maintained within 1% during operation, within 3% in transition. Synchronization is automatic, operation is unattended. Units from 5 to 200 kw.



**Where UPS can help you**

Wherever your manufacturing depends on power, Condec's UPS wipes out the hazards of danger, damage or dollars that can be caused by even 1-second power losses. For more information, or a free demonstration at our plant, write or call Mr. Frank Cesario, Consolidated Diesel Electric Corporation; telephone Davis 3-2261.

POWER EQUIPMENT DIVISION

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# Bookshelf

**Marine Corrosion Handbook.** *By T Howard Rogers, 320 pp, 48 illust, $12.50. McGraw-Hill Company of Canada Ltd.*

*Reviewed by H H Uhlig, head of corrosion lab, Mass. Institute of Technology Dept of Metallurgy*

This modest sized 320-page handbook deals with marine corrosion in a conversational style. Unlike most handbooks, it treats the subject qualitatively and almost completely bypasses tables of data, but it includes a series of photographs illustrating examples of marine corrosion. In a succinct manner, the author treats a range of subjects in alphabetical order starting with *admiralty brass* and ending with *zinc chromate.* A glossary of terms and definitions is appended. The latter is especially helpful to anyone starting out in the subject. (The reviewer noticed one error—anode is defined as the positive and cathode as the negative electrode of an electrolytic cell. Actually the polarity depends on whether current is impressed or drawn from the cell.)

The reader learns in 2½ pages, for example, about all inhibitors. Various types are described, but there is no mention of proper concentrations or precautions for specific applications. Under *chromates,* however, recommended concentrations are given for diesel-engine cooling systems and for steel systems in general. *Corrosion testing* is covered in 1½ pages. *Aluminum* is treated in 33 pages, reflecting the particular interest and experience of the author; *stainless steel* receives only 1 1/3 pages.

The handbook is a potential aid to an engineer or designer concerned with corrosion problems in ocean-going ships, including marine boilers, paints, galvanic effects, welding and the use of various metals and alloys for specific purposes. For further minimum details on any subject, the reader must be willing to consult additional sources of information such as the six reference volumes on corrosion by various authors listed at the beginning of the book. Only

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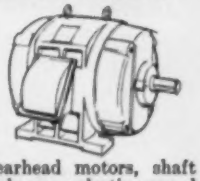

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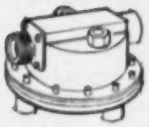

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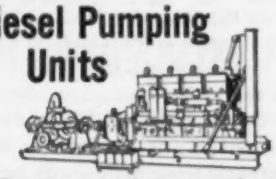

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## Bookshelf

continued

very few references to the general literature are mentioned. In addition, the handbook serves primarily as a guide to vocabulary and elementary concepts employed in corrosion science and corrosion engineering.

—H H Uhlig

**Plumbing,** *Third Edition. By Harold E Babbitt, Engineering Consultant. 642 pages, 7x9, 452 illust, 260 tables, $13.50. McGraw-Hill Book Company, 320 W 42nd St, New York 36, N. Y.*

This new edition of a standard guide to plumbing practice covers the entire subject from basic hydraulics, mechanics and pneumatics to design of systems; use of materials, equipment, and fittings; methods of installation and repair.

Many advances are reflected in this edition, including recent applications of hydraulics and pneumatics to design of drainage pipes, traps and vent pipes. New chapters have been added on hot-water supplies and storage tanks.

Examples of troubleshooting methods, installation mistakes to avoid and other helpful pointers are included, along with a glossary of some 350 technical terms used in plumbing. In addition, there is an extensive list of standard specifications of plumbing materials, equipment, pipes and fittings, together with 76 tables and accompanying illustrations showing weights, dimensions and details.

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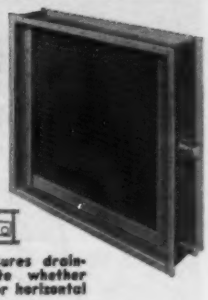

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George Edwards

## suggests: Remember that as the twig is bent . . .

I'd like to take you on a little trip with me. We're going to Stamford, Conn. and we're going to visit the Alpha-Molykote Corp's lab. It's Saturday morning, and as we walk into the lab we'll see a small group of people deeply absorbed in a scientific experiment. It may deal with analytical chemistry, physics or electricity. Or the group may be making some microscope studies, or investigating jet-propulsion principles.

Nothing unusual about this, you'll say; it's going on in labs across the country. But take a closer look at our scientists and you'll see that three of them are 9-year-old boys; the fourth youngster, and female member of the team, is an 8-year-old 2nd grader. Two adults with them are Dave Noltie, Vice-President of Alpha-Molykote, and Al DiSapio, a lab technician. Let's let Dave tell us what's cooking, and I think you'll like what you hear:

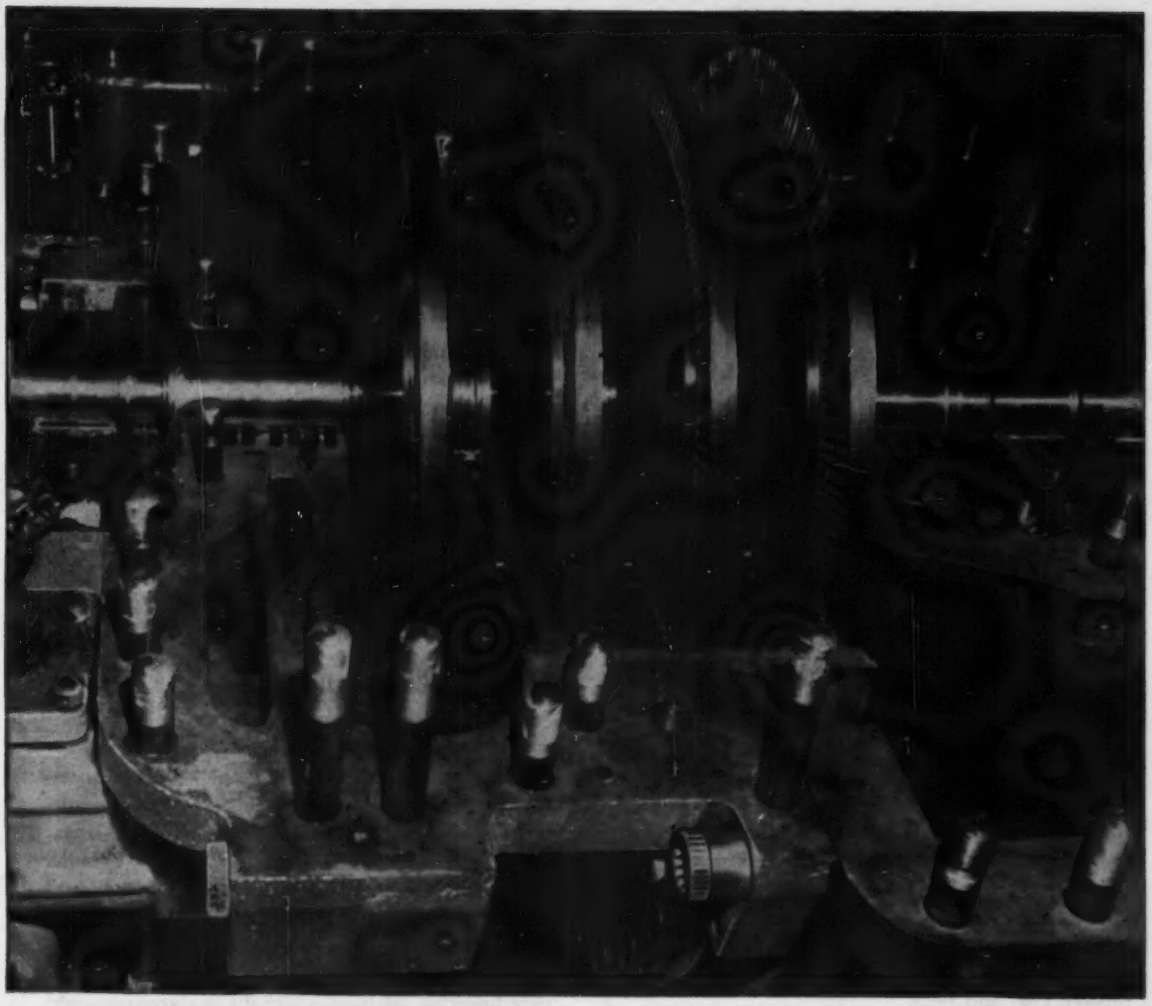
"In today's world it's only natural that much emphasis is placed on science. Industry needs scientists; educators are clamoring for more science courses, more equipment and better teachers. My contention is that our school system can do only so much. We, as parents, with a little ingenuity can make learning an exciting process and instill enthusiasm in young minds.

"Let's take a look at American industry. Here we have a multibillion-dollar complex spread around the country with magnificent laboratories, highly skilled technicians. Laboratories operate five days per week in most cases. They are idle evenings, Saturdays and Sundays. Even if we take only Saturday and Sunday afternoons the idle capacity is 12 hours per week.

"I propose that we harness these facilities and the many wonderful and capable instructors to teach our children. The costs would be modest and could easily be paid for by industry. Possibly tax advantages could be given to corporations paying employees who would instruct if the program became large. I know management would be cooperative.

"For the past seven months we've held a science class in our lab for my two oldest children, eight and nine, and two neighbors' children, both nine. Al teaches the class and he has ingeniously devised equipment to match 8- and 9-year-old imaginations. He may have them test various foods to see how $CO_2$ is produced through fermentation with yeast. He may show them how to detect various substances by using indicators. They use microscopes to study blood cells, yeast-plant cells, bacteria (from children's teeth), insects, or watch sodium-chloride crystals grow. After viewing, they sketch what they have seen. Laws of physics are brought into play, observed, discussed. They may construct a simple coil magnet, a simple electric motor or a telegraph key and receiver. And so on.

"Class starts promptly at 8 am and ends at 9:15. The children's interest is unbounded and they're rarin' to go early Saturday mornings. We've got something worthwhile going, and we'll build on it. Wouldn't it be wonderful if more eager young minds in America today could have this training?"



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Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

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A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

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# Recent Economic Growth — The Numbers Game

**If it truly portrayed recent rates of economic growth in the United States, the report on employment, growth and price levels recently issued by the staff of the Joint (Congressional) Economic Committee would point up scarcely less than a national disaster.** Among other things, it would document impressively Premier Khrushchev's crack that "the capitalist steed the United States is riding . . . is worn out."

One of the major findings of the Joint Committee's staff (in the Eckstein Report, named for its staff director Otto Eckstein) is that between 1953 and 1959 the average rate of growth of physical output in the United States was only 2.4 per cent per year. This is scarcely more than half the average annual rate of growth of 4.6 per cent the staff found to have prevailed between 1947 and 1953.

**Happily, however, the report does not reflect the basic economic realities.** Its finding on relative rates of economic growth for the two periods is a statistical *tour de force* which, by the selection of certain figures and certain dates, distorts the record of America's long-term economic growth.

## Playing The Numbers Game

By the selection of appropriate starting and terminal periods it is possible to document almost any rate of economic growth that is desired. The table at the bottom of this page shows you how this can be done. It will also show you how the Eckstein staff worked out its shocking contrast in growth rates. The table is built like a schedule of airplane fares between different cities. The postwar years 1946 through 1959 are put down on two axes. One runs down the left hand column, the other runs across the top of the table. Put your finger on the point where the two axes intersect and you have the average rate of growth for the period covered.

**ANNUAL AVERAGE GROWTH RATES OF THE U.S. ECONOMY, 1946-1959***

(Percent increases, starting year to terminal year, of GNP in 1954 dollars).

| Starting Year \ Terminal Year | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1946 | X | -0.1 | -1.9 | -1.2 | 3.0 | 3.9 | 3.8 | 3.9 | 3.2 | 3.7 | 3.6 | 3.4 | 2.9 | 3.2 |
| 1947 | X | X | 3.8 | 1.8 | 4.1 | 4.9 | 4.6 | 4.6 | 3.7 | 4.2 | 4.0 | 3.8 | 3.2 | 3.5 |
| 1948 | X | X | X | -0.1 | 4.2 | 5.3 | 4.8 | 4.7 | 3.6 | 4.3 | 4.0 | 3.8 | 3.1 | 3.4 |
| 1949 | X | X | X | X | 8.7 | 8.1 | 6.5 | 6.0 | 4.4 | 5.0 | 4.6 | 4.2 | 3.5 | 3.8 |
| 1950 | X | X | X | X | X | 7.4 | 5.4 | 5.1 | 3.4 | 4.3 | 3.9 | 3.6 | 2.9 | 3.3 |
| 1951 | X | X | X | X | X | X | 3.4 | 3.9 | 2.0 | 3.5 | 3.2 | 3.0 | 2.2 | 2.8 |
| 1952 | X | X | X | X | X | X | X | 4.4 | 1.3 | 3.6 | 3.2 | 2.9 | 2.0 | 2.6 |
| 1953 | X | X | X | X | X | X | X | X | -1.6 | 3.2 | 2.8 | 2.6 | 1.6 | 2.4 |
| 1954 | X | X | X | X | X | X | X | X | X | 8.1 | 5.1 | 4.0 | 2.4 | 3.2 |
| 1955 | X | X | X | X | X | X | X | X | X | X | 2.1 | 2.0 | 0.5 | 2.0 |
| 1956 | X | X | X | X | X | X | X | X | X | X | X | 1.8 | -0.2 | 2.0 |
| 1957 | X | X | X | X | X | X | X | X | X | X | X | X | -2.3 | 2.0 |
| 1958 | X | X | X | X | X | X | X | X | X | X | X | X | X | 7.0 |
| 1959 | | | | | | | | | | | | | | |

*Compound rates of growth

Following this procedure, you can find growth rates ranging all the way from —2.3 per cent, between 1957 and 1958, to +8.7 per cent, between 1949 and 1950, along with almost any other rate you would choose for various years and sequences of several years over the postwar period.

For example, if you want to demonstrate that the postwar growth rate through 1953 was less than 4% per year, you take off from 1946, include a drop of 0.1 per cent between 1946 and 1947, and come up with a growth rate for the 1946-1953 period of 3.9 per cent. But if you want to show it was quite high, you take off a year later, from 1947 (which drops out that dismal —0.1 per cent for 1947) and come up with a fine growth rate of 4.6 per cent for the 1947-1953 years.

## Statistical Hocus-Pocus

That's what the Eckstein staff did. It took off at one end from a year when there was just about no growth, went to the Korean War boom year of 1953 at the other end, and got that average growth rate of 4.6 per cent. Then it took off from the Korean War boom year of 1953 and ran to the year 1959, when business was recovering from a recession and suffered through a steel strike of 116 days, to come up with its 2.4 per cent growth rate for the second postwar period. As the table indicates, by taking off a year later (1954) the average growth rate would have become 3.2 per cent, and if the take off had been 1949 it would have been 3.8 per cent.

**There are those who, in nontechnical terms, would characterize this as statistical hocus-pocus. There are also those who would see in it an element of political hocus-pocus, too.** This is because the years 1947-53, when the Eckstein staff found there had been the healthy 4.6 per cent growth rate, were roughly years when we had a Democratic president, while the anemic growth rate of 2.4 per cent it calculated for the subsequent years was for years of a Republican presidency.

Actually it can be shown that the civilian part of our economy has had more rapid growth during the Republican administration than it had during the Democratic years. If military expenditures are subtracted from the national ouput, the resulting growth rate for 1953 to 1959 is slightly higher than for 1947 to 1953.

However, we do not question the *bona fides* of the Eckstein staff. **But we do assert that it has produced a statistical picture of the postwar growth of the American economy which is dangerously misleading both at home and abroad.**

Abroad, the report appears to give official documentation to the propaganda line that the Soviet economy is running rings around the U.S. economy in growth, and that it is Communism a country should choose if it really wants to develop rapidly. Building on a much smaller economic base than the U.S.A., the Soviet Union — as well as almost every less advanced nation in the world — is bound to show a larger percentage increase in output than the U.S.A. But the Eckstein staff calculation gives the Communists ammunition they don't deserve.

## Are We Facing A Crisis?

The contrast drawn by the Joint Committee staff in postwar U.S. growth rates suggests that we are facing scarcely less than a crisis through paralysis of our economic growth which calls for drastic remedies. But this, as the full 1947 to 1959 growth record set forth in the table makes clear, is very definitely not the case. Our over-all postwar rate of growth, as measured by the gross national product in physical terms, has been 3.5 per cent per year, a rate nearly double the long-term growth rate of 2 per cent per year between 1909 and 1939. In the continuing fluctuations in the rate of growth which more or less inevitably characterize a relatively free economy, we have had some downs in recent years. **But our economy is now on the upbeat again. And at the end of this year, the U.S. economic growth rate for the postwar period can be expected to be 3.7 per cent per year.**

**It is extremely important for the United States to continue to maintain this rate of economic growth or even to surpass it.** Upon this effort depends our capacity to meet our defense requirements without dangerous strain, to provide an adequate margin for foreign aid, to improve our own productive facilities, and to continue to raise our own standard of living.

How not only to maintain but possibly improve upon our postwar pace of economic growth will be the subject of strenuous debate in the months ahead. However, the debate will have a much better chance of being constructive if the postwar growth record is seen in proper perspective. To this end one of the first things to do is to junk panic rousing statistical portrayals such as that in the Eckstein report.

*This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.*

Donald C. McGraw

PRESIDENT

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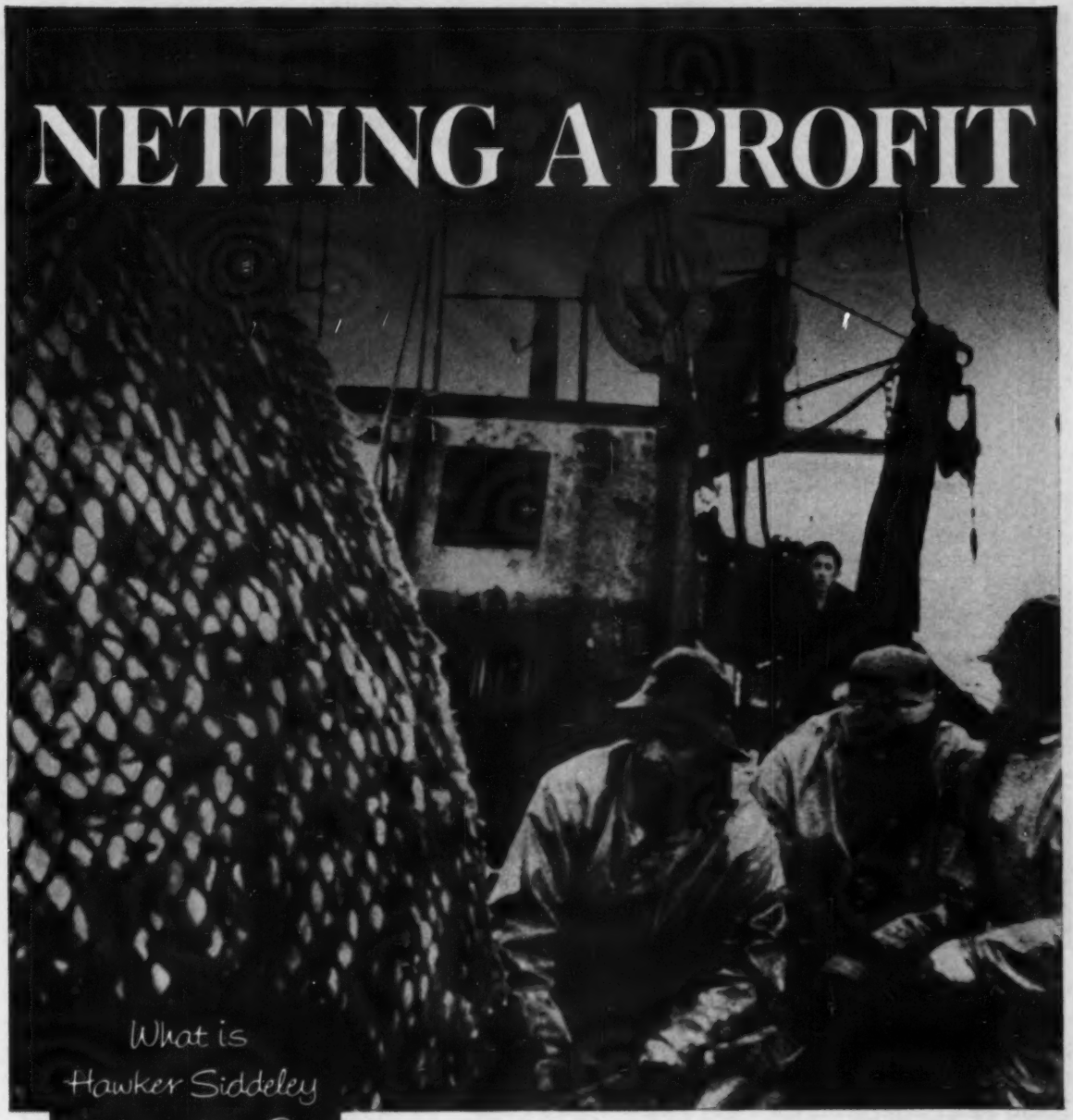


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**THE RESINOUS PRODUCTS DIVISION**

**Washington Square, Philadelphia 5, Pa.**



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## Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge

**CARE** and cleanliness plus know-how promise a long life for this babbitted bearing

**Send the job out or have your own men handle it? That's a question that pops up frequently. Here's what you must know before deciding on . . .**

# In-plant babbitting of bearings

By W J REICHENECKER and D K FOX
Materials Engineering Dept
Westinghouse Electric Corp

Despite long strides in development of bearing types and materials in recent years, there still remains a wide field for application of conventional babbitted bearings to heavy rotating equipment. Lead- or tin-base alloys are used for the bearing surface and, depending on application, steel, cast iron, copper, leaded bronze and stainless steel are used for backing materials. Mechanical anchoring, metallurgical bonding or a combination of both secure babbitt to backing material in making up the bearing.

**Lubricants** and lubricating systems, too, have come a long way. There's been much research in these areas; self-evident result is increased bearing service life. But a number of factors team up to induce bearing wear under certain circumstances, making bearing maintenance a vital part of heavy-equipment operation. Since maintenance inevitably involves rebabbitting bearings, plant management should consider economics of doing this job in-plant rather than sending worn bearings to an outside shop. To help you

## Follow these ground rules for best bearing performance

analyze the pros and cons, let's take a close look at heavy-duty bearings and the rebabbitting operation.

**Mechanical bonding** of babbitt to bearing shell (backing material) is satisfactory for many applications. Kind of bearing-shell material has little or no effect on babbitting. Dovetail or other anchor grooves are machined into the shell, poured molten babbitt solidifies and grooves firmly anchor it in place.

**Metallurgical bonding** is somewhat different. Here the backing material must be tinned and specific procedures followed during babbitting. In our discussion we'll deal only with heavy-walled shells, photo on first page, typical of those used with heavy equipment.

**Cardinal rule** for rebabbitting is *cleanliness*, and this can't be overemphasized when a bearing shell is being prepared for tinning. Surfaces to be babbitted must be protected from oil, grease, oxidation or any contamination which could affect uniformity and adherence of the tin coating. Final machining must be performed dry; cooling fluids would contaminate the surface. Further, final machining should produce a phonograph finish.

After machining, don't touch surface to be babbitted when handling shell. Avoid dirty or oily gloves, or wiping machine surface with rags or waste, or touching it with bare hands.

Actual tinning should be done as soon as possible after machining. If babbitting can't follow immediately, tin the shell and allow it to cool. Tinning protects the surface until bearing can be babbitted. When you're ready, shell can be reheated in the tin pot, immersed in flux and then allowed to soak in the tin pot until it comes up to proper temperature for babbitting.

Preparation for tinning and subsequent babbitting will vary somewhat according to shell material. Bronze, cast-steel and stainless shells are rather easily tinned. But cast iron must have surface graphite removed by an oxidizing salt bath. If graphite isn't removed, it'll seriously interfere with good fluxing and tinning operations. Once cast-iron shell has had a salt-bath treatment it isn't necessary to repeat it unless surface has been remachined.

**Detailed procedures** for tinning various shell materials are given in tables I to IV. These are based on techniques used for handling large numbers and a wide range of bearing sizes and styles. If an emergency rebabbitting job on a cast-iron shell in the field is necessary, and shell hasn't previously been treated to provide a metallurgical-bond lining, best bet is to do the job as suggested for cast-iron shells without any attempt at tinning. In this case, secure the babbitt with dovetail grooves or other mechanical anchors.

No simple expedient can take the place of a salt-bath treatment, but trying to improvise salt-bath equipment in the field is quite difficult. Strictly a stopgap, the mechanically anchored babbitt in the cast-iron shell should be used only until you can obtain a properly tinned replacement bearing.

**Hand fluxing** and tinning can be used instead of flux and tinning baths when only a few small-sized bearings are to be made. Shells must, of course, be held at a temperature of about 300 C during tinning. Torches can be played over the shell, but flame shouldn't contact areas to be babbitted. Rub these surfaces with a flux-saturated swab just before applying tinning alloy. Apply tin by rubbing with sticks of alloy. Alternate fluxing and tinning will provide a suitably tinned surface. With larger bearings, hand method generally doesn't produce good results.

A wide variety of fluxes may be used in tinning bearings. Water solution of zinc and ammonium chlorides with a small amount of hydrochloric acid added makes a satisfactory flux, though other chloride salts may also be used. When shells are immersed in tinning alloy, it's important to give them enough time for uniform heating—but excessively long heating should be avoided. Too much time may allow a brittle interface layer to form.

Tin-coating quality is easily checked by visual examination. Coating should appear uniform, continuous, with no tendency to "ball up." Poor coating will show areas where tin has drained away, exposing base metal, or tin may form small, independent puddles much like water poured on a waxed surface. If you doubt coating quality, reprocess shell as indicated in the tables.

**Static babbitting** of shells usually involves pouring babbitt after mounting shell in a fixture designed to provide proper contour and thickness of babbitt layer plus allowance for machining. Closely control the process. Babbitt solidification should progress from bottom to top and from shell-babbitt interface to mandrel-babbitt interface. To accomplish this, mandrel's temperature must be higher than bearing shell's. Further, top of mandrel should be hotter than bottom so babbitt at top of bearing will remain molten and continue feeding to compensate for shrinkage as the alloy solidifies. Temperature can be checked easily by using temperature-indicating crayons (see POWER, May 1957, p 122) or contact pyrometer.

These steps should produce a satisfactory job:

1. Heat mandrel to about 325 C at bottom and from 350 to 375 C at top. Apply torch to upper half
2. Clamp hot (280- to 300-C) tinned bearing shell to mandrel
3. Pour babbitt in a continuous stream if possible. Preheat hand ladles; if ladle is small, pour as fast as possible to prevent a layer effect in the finished babbitt. Pouring temperature, depending on alloy, will normally be 400 to 500 C. Protect iron ladles and skimmers with a coating of whiting when using tin-base babbitts because these will attack iron and contaminate

the alloy if care isn't used. Thickness of whiting isn't critical, but coating should be continuous. If cracks appear in coating, repair them immediately. Thoroughly dry the ladles before reinserting them in molten babbitt

4. Let assembly cool naturally to room temperature, but to get proper directional solidification of babbitt it's advisable to blow air on outside of shell near the bottom. Water spray can be used, but this is hazardous with molten babbitt. If you use spray, be sure water and babbitt don't contact each other
5. As bearing cools you'll need to add babbitt to compensate for shrinkage as it occurs. This can be done with a riser ring at the top of the shell. Pour alloy to top of riser and no more will be needed during solidification. If you use a riser ring, make sure it's heated to same temperature as top of mandrel
6. When cool, remove bearing from mandrel and machine babbitt to finished thickness and contour

Importance of proper directional solidification can't be over-emphasized. Unless alloy freezes progressively from bottom to top and from shell to mandrel there'll be little or no bond plus the possibility of shrinkage defects or porosity. Procedures outlined have been used for a number of years, give satisfactory results when carefully followed.

**Caution** must be used when working with molten metal, molten caustic salts and strong acid fluxes. Equip personnel with adequate protective clothing from head to toe. Prevent flux from splashing into tinning alloy, don't put wet ladles into the alloy and don't put fluxed shells rapidly into the alloy. It's difficult to outline safety procedures applicable in all circumstances. Best bet is to have a healthy respect for nature of materials used, and to plan carefully.

## Good babbitting begins with proper tinning

### I Tinning cast-iron bearing shells

1. Remove rust, scale, other foreign material by machining, shot or sand blast
2. Heat shells to 450 C
3. Immerse preheated shells in molten salt compound for 15 to 20 min to remove surface graphite
4. Remove shells from salt bath, drain excess salt. Immediately immerse in cold water for 30 sec. Be sure shells have no salt pockets—reaction between molten salt and water is violent and can be hazardous
5. Transfer shells to tank of circulating hot water, allow 5-min rinse. If possible, agitate water for thorough salt removal
6. Remove from hot water and immerse shells for ten min in a 10% aqueous solution of hydrochloric acid
7. Rinse shells in hot water
8. Immerse shells in flux bath—usually aqueous solution of chloride salts —for 15 sec
9. While they're still wet with flux, immerse shells *slowly* in molten alloy held at 325 C. Shells should be completely submerged until uniformly heated to about 300 C. If tinned coating isn't satisfactory, reflux and retin the shell two or three times. If still unsatisfactory, repeat whole operation starting with step 3. If tinning is satisfactory, shells are ready to be babbitted

### II Tinning stainless-steel bearing shells

1. Follow steps 1 and 2, table 1, above
2. Immerse shells in molten salt compound for five min
3. Remove shells from salt bath, drain excess salt. Immediately immerse in cold water for 30 sec
4. Transfer shells to tank of circulating hot water, allow 5-min rinse. If possible, agitate water for thorough salt removal
5. Remove from hot water and immerse shell for four min in a 10% aqueous solution of hydrochloric acid
6. Submerge shells in flux bath or thoroughly swab surfaces to be tinned. Water solution of chloride salts makes a satisfactory flux
7. Transfer shells to tinning bath, allow to soak until tin remains molten when shell is withdrawn from bath
8. Immerse shells again in flux bath for ten to 15 sec
9. Put shells back in tinning bath, allow to soak until uniformly heated to 300 C. Keep shells submerged during soaking
10. When satisfactorily tinned, shells are ready for babbitting

### III Tinning cast-steel bearing shells

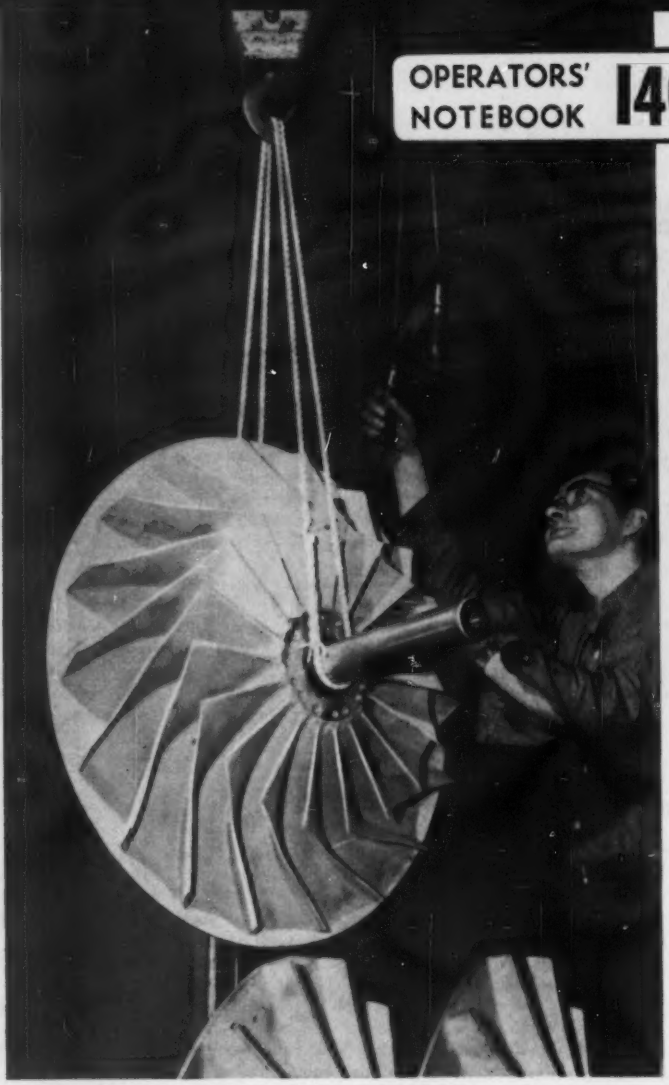
1. Follow step 1, table I
2. Degrease shells
3. Immerse shells in flux bath for 15 sec
4. While they're still wet with flux, transfer shells to tinning pot held at 325 C and immerse slowly. Keep them submerged until temperature rises to point where alloy remains molten when they're withdrawn from tinning pot
5. Immerse shells again in flux bath for 15 sec
6. Submerge shells again in tin pot and allow to soak until they're uniformly heated to 300 C
7. When satisfactorily tinned, shells are ready for babbitting

### IV Tinning copper and leaded-bronze shells

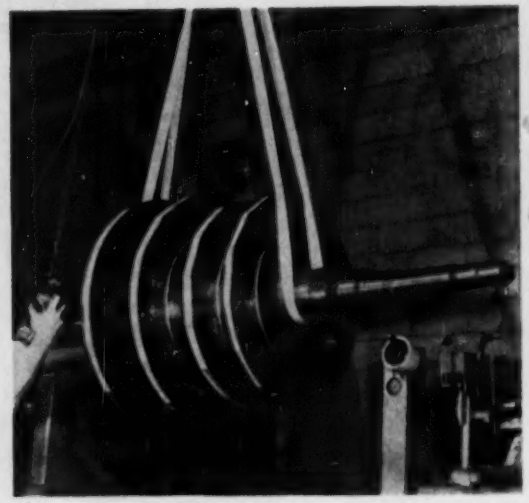
1. Follow step 1, table I
2. Degrease shells
3. Immerse in flux bath or hand swab areas to be tinned
4. Submerge shells in tinning pot held at 325 C. Keep shells submerged until alloy remains molten when shell is withdrawn from pot
5. Immerse shells again in flux bath for 10 to 15 sec or thoroughly swab surfaces to be tinned
6. Submerge shells again in tin pot and allow to soak until they're uniformly heated to 300 C
7. When satisfactorily tinned, shells are ready for babbitting

OPERATORS' NOTEBOOK **140**

# Synthetic



**NYLON ROPE** easily sustains weight of impeller wheel from a large compressor



**NYLON WEBBING** hoists a 1500-lb impeller-shaft assembly during shop repairs

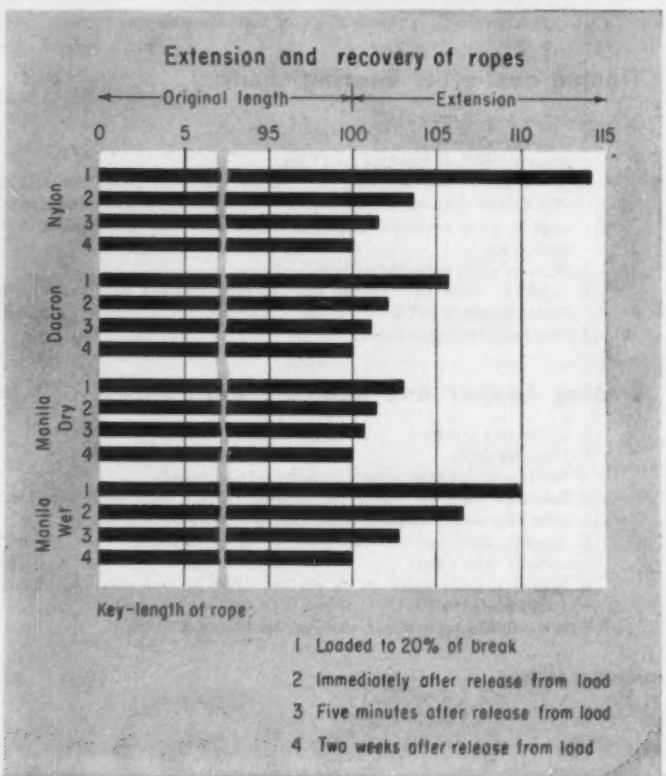
## Sturdy, lightweight

Synthetic cordage handles heavier loads faster today because new "miracle" fibers are both stronger and lighter—a big plus in industrial-plant preventive maintenance. Whether you must lift steel tubing, compressor shafts or oil drums, synthetics bid to do the job quicker and safer. See *Pick it up*, May 1953, for information on Manila and chains.

Using nylon and Dacron polyester fiber, cordage makers are turning out products noted for strength, uniformity, and resistance to rot and mildew, traditional enemies of natural fibers. Nylon ropes are over twice as strong as Manila ones of comparable size; Dacron is about twice as strong.

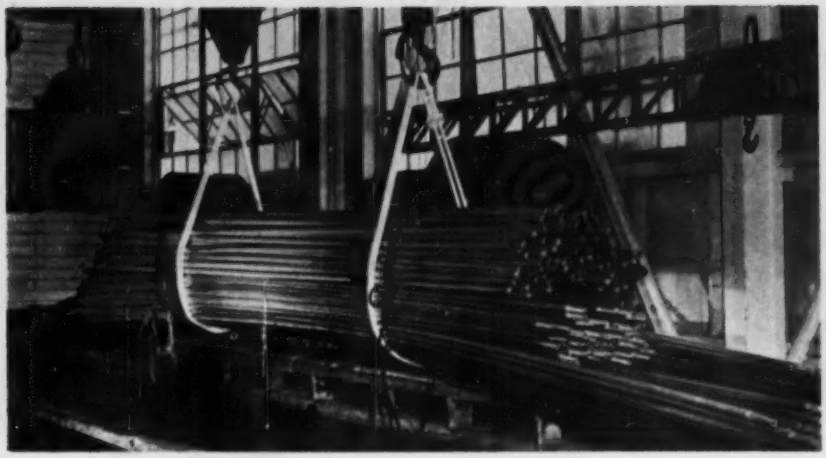
**Latest improvement** in synthetic cordage is the new Du Pont nylon, Type 707. It boosts rope's breaking strength about 16% above regular nylon—dry breaking strength of a 5½-in.-circumference Type 707 rope is 87,000 lb, compared to 75,000 lb for regular nylon. The new yarn triples ability to withstand repeated loading of this material.

Sailors, mountain climbers and cowboys have accepted these new ropes; in industry, synthetic cordage is still something of a stranger. One reason: jobs it can do are so diverse they're hard to pinpoint. Here are



# cordage speeds modern maintenance

By STEVE ELONKA, Associate Editor



**DACRON POLYESTER FIBER** endless slings give this 5000-lb bundle of stainless-steel tubing a highly corrosive ride through pickling solution—and they do the job safely

**CRANE LOADING** of heavy oil drums is speeded by nylon webbing with choker hitch

## synthetics promise safer handling of heavier loads

advantages some industrial users found when they got to know the synthetic-fiber ropes:

**A large manufacturer** of air-conditioning equipment uses many types of slings, some of cordage, others of webbing, in the machine and assembly shop. One sling transports heavy compressor shafts and wheels along the production line. Coolant used in machining degraded Manila slings so rapidly they lasted only about 12 days. Slings made of nylon and Dacron took over, have served for eight months. One is still going strong after more than a year.

Coolant-soaked Manila slings picked up steel filings from the machining operations and scored highly machined critical surfaces. Tight construction of nylon and Dacron won't let such chips get a foothold in the slings. This plant also replaced wire cable with synthetic rope. Wire had to be padded when moving electronic control units—no padding for the synthetics.

**A tube firm** needed a sling for moving stainless-steel tubing, 5000 lb at a shot, through pickling and cleaning operations. Natural-fiber rope disintegrated rapidly in the nitric-hydrofluoric-acid pickling solution. Metal chains, while durable, tended to mark and dent surface of tubing. Now they use ¾-in. Dacron rope made into endless slings. Slings last about six months; less tubing is rejected because of handling marks.

Neoprene-impregnated nylon belting handles other sling duties at this mill. They also use slings of hard-lay nylon, chosen for stiffness and wear resistance.

Some cordage makers produce webbing made of nylon and Dacron for heavy-duty slings and nets. In one construction, woven outer covering protects a core of nylon or Dacron parallel-filament yarns. Another sturdy version known as *slotted nylon webbing* is used for cargo nets by the Navy and Air Force.

**A grain elevator** used Manila ropes, figuring them to last an average of 475,000 bushels. But Dacron was still going strong after unloading 3,000,000 bushels. Even more important are savings in time and manpower: Dacron lets them use bigger scoops, breaking what once was a 6-hr job for 16 men into a 4-hr job for ten men.

**Ease of handling** is a prime requirement in maintenance work. Nylon and Dacron ropes weighing in at half the poundage of natural-fiber ropes can be used in many applications; replacement of natural-fiber ropes can usually be made on an equal-strength rather than equal-size basis. And ropes of nylon and Dacron boast another advantage—exceptional flexibility.

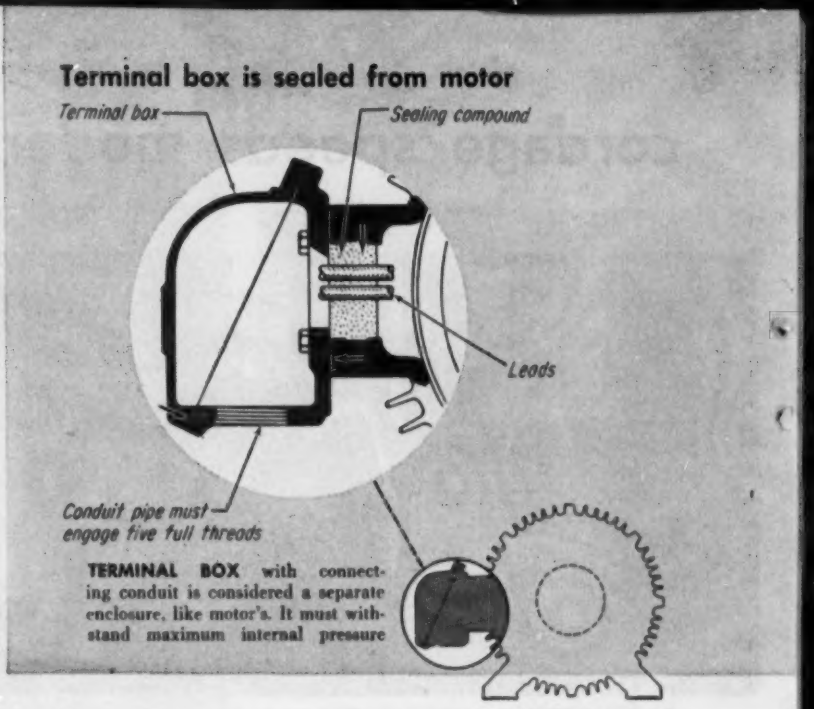
You can splice properly made synthetic ropes as easily as natural fiber by taking a few precautions. To maintain a neat-looking splice, twist should be held in the free ends of the strands while taking the tucks. Strand end should be taped and, especially for large ropes, it's helpful to tape individual strands in a number of places as soon as the end of the rope is unlaid.

**Stability to change in length.** Ropes of nylon and Dacron exhibit little change in length when exposed to constant soaking in water or to a normal range of temperatures. Ropes remain flexible and easy to handle even after prolonged soaking. This is a highly important quality.

**Resistance to rot and mildew.** Prolonged exposure has shown that Dacron polyester fiber and nylon aren't attacked and weakened by rot and mildew. Ropes of either fiber can be stored wet without fear of permanent loss of strength—another quality suiting synthetic ropes for industrial maintenance work.

By S F HENDERSON
Westinghouse Electric Corporation

**Effectiveness of explosionproof motors depends on how well you maintain original features to seal enclosure and prevent ignition. These tips help . . .**


Terminal box is sealed from motor
Terminal box
Sealing compound
Leads
Conduit pipe must engage five full threads
TERMINAL BOX with connecting conduit is considered a separate enclosure, like motor's. It must withstand maximum internal pressure

# Keep your explosionproof motors safe

Proper maintenance of explosionproof motors requires a clear understanding of design objectives. National Electrical Code (Art. 100) says an explosionproof motor must be "enclosed in a case which is capable of withstanding an explosion of a specified gas or vapor which may occur within it, and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes or explosion of the gas or vapor within, and it must operate at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby." Motors are built to meet these requirements.

These motors are required by NEC for Class-I Div-1 locations where hazardous concentrations of flammable vapors or gases are likely to occur in the course of normal operations. Various atmospheric mixtures have been grouped by Underwriters' Laboratories, Inc on the basis of their hazardous characteristics. Here they are in descending magnitude of hazard: Group A—acetylene; Group B—hydrogen, or gases or vapors of equivalent hazard such as manufactured gas; Group C—ethyl-ether vapors, ethylene or cyclo-propane; Group D—gasoline, hexane, naphtha, benzine, butane, propane, alcohol, acetone, benzol, lacquer, solvent vapors or natural gas.

**Enclosure** of an explosionproof motor, above right, is designed to withstand with ample safety margin the maximum explosion pressure that may occur within the enclosure without bursting or loosening joints. Adjoining surfaces of metallic frame and brackets are machined to form "flame paths" that quench any flame before it can leave the enclosure. Length and clearances of shaft openings are similarly constructed to quench the flame resulting from an internal explosion. Leads or conductors from windings within the enclosure are securely held and tightly fitted, usually with sealing compound, where they pass through the enclosure.

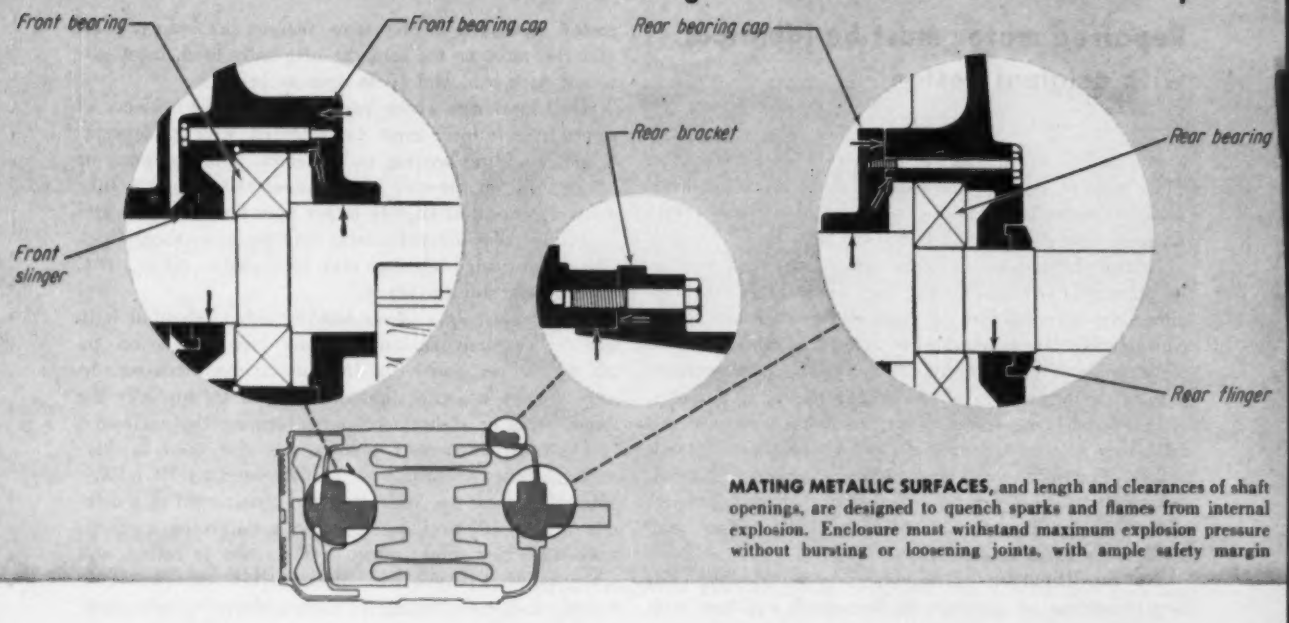
Connection to the power-supply line generally uses a metal conduit, either direct or through a terminal box. Terminal box with connecting metal conduit is considered a separate enclosure, and like the main motor enclosure must withstand maximum internal explosion pressure without bursting or loosening its joints. Bolts used to hold enclosures together are strong and spaced to prevent a dangerous increase in the clearances of the flame paths during an explosion.

External fans are of nonsparking material, such as aluminum, medium brass, or plastic with electrical resistance low enough to prevent building up a charge of static electricity. Fans are substantially mounted with ample clearance between revolving and stationary parts. Strong fan guards are provided.

**Safety** in hazardous locations is endangered if openings or other alterations are made in these motors. *Continued safety depends on proper maintenance* and suitable overload and short-circuit protection. A "safe" motor is readily made "unsafe" for use in a hazardous atmosphere by careless or inadequate maintenance. Improper bolt tightening when mounting the terminal-box cover after making connections to the power supply is a danger point, even if only one bolt is loose. Should an explosion occur within terminal box the joint between cover and body might open up enough to let flame out to ignite the surrounding explosive atmosphere.

**Maintenance** of explosionproof motors, most of which are ac induction types, involves attention to the (1) en-

**Enclosure designed to contain internal flash or explosion**




**MATING METALLIC SURFACES,** and length and clearances of shaft openings, are designed to quench sparks and flames from internal explosion. Enclosure must withstand maximum explosion pressure without bursting or loosening joints, with ample safety margin

closures (2) electrical windings and (3) bearings.

Preventive maintenance starts when you select the motor and its control. Motor must be able to do the work demanded of it without exceeding rated temperature rise. Control must provide overload protection to limit operating temperatures within motor's rating and cut possibility of winding burnouts (for details see Underwriters' Laboratories' Card Data Service, Serial No. UL 561). Control must provide short-circuit protection to prevent destruction of motor and limit disturbances to rest of the line. Protection against lightning should be provided and transient overvoltages during switching minimized.

When installing an explosionproof motor, in addition to usual precautions, take extra care. Make sure motor can get all the ventilating air it needs. Make connections to power supply through metal conduit with *at least five threads fully engaged*. Where connections must be flexible use only approved fittings. When closing terminal cover be sure that ground-metal surfaces which form the flame path aren't damaged. After assembly tighten each bolt carefully. Seal conduit as per NEC Art. 500 to prevent passage of gas or vapors. Follow manufacturer's recommendations for oil-lubricated bearings.

Enclosure requires good housekeeping. Eliminate any ventilation restriction that might cause overheating. Remove accumulated dust or dirt. Avoid contact between stationary and rotating parts.

**Electrical windings** are subject to many deteriorating factors. Most important in explosionproof motors of common sizes are (1) thermal aging by cumulative time-temperature effects (2) moisture absorbed into the solid insulation and accumulated on the insulating creepage surfaces (3) conducting contaminants—combinations of dirt, chemicals, oil and the like (see AIEE No. 56, "Guide for insulation maintenance for large—10,000 kva or more at 6000 volts or more—alternating-current rotating machinery" for other factors that deteriorate windings).

Effective preventive maintenance for windings starts with selecting a motor which doesn't overheat, and specifying appropriate insulation when unusual moisture or chemical conditions exist. Keep motor clean and dry before startup. Avoid causes of overheating: (1) overload (2) reduced ventilation (3) high ambient temperature (shouldn't exceed 40 C for any appreciable time unless allowances were made in selecting the motor) (4) incorrect or unbalanced voltages (voltages balanced in magnitude and phase angle should be within 10% of nameplate value. A small unbalance in voltage causes a large increase in motor losses) (5) thermal blanketing by layers of dust or dirt which gradually accumulate.

**Bearings** for explosionproof motors may be ball or sleeve types, with ball bearings predominating in motors above one hp. Follow good lube practice strictly, using lubricant recommended by manufacturer. Keep track of increase in the noise or operating temperature of a bearing—it may serve as advance warning of failure.

**Repairs** involve more than normal concern and care. In addition to usual considerations in repair of standard motors, make sure that continued operation in hazardous areas is not impaired. Underwriters' Labs recommend: "when rewinding or other servicing is required the motors be returned to their manufacturers or that such servicing be on the basis of advices from the manufacturers." Repairs are usually made in the user's maintenance department, the manufacturer's shop or an independent repair shop. Quality and safety of repair depends on ability and knowledge of those making it. Don't let personnel unfamiliar with requirements of explosionproof equipment work on your motor.

Before taking motor to a nonhazardous area for repair, de-energize it with appropriate motor controller and disconnecting means. Withdraw terminal-box bolts and carefully remove cover so that no injury is done to ground metallic surfaces that form the flame path between cover and body of box. To prevent accidental damage to these surfaces cover them with masking tape

## Repaired motor must be identical with original design

—it's vital to avoid nicking, grooving or other damage. Then remove power-supply connections to motor leads and disconnect conduit. Replace conduit-box cover with masking tape still on, and fasten the bolts.

In a nonhazardous area removal of fan guard and fan is standard procedure. Further disassembly involves either the terminal-box or main-motor enclosure; here considerable care is required to avoid damage to finished metal surfaces that form the flame paths. Don't use hammers or prying tools; avoid nicking, grooving or gouging.

Detailed UL requirements for maximum clearance and minimum length of flame path can be found in "Standard for electric motors and generators for use in hazardous locations," Class I, Groups C and D, Part I, Subject 674 (B), eighth edition dated May 1950, revised May 1958, for integral-hp motors.

**No modification** of enclosures is permissible. Fill deep scratches or grooves in flame-path surfaces with firmly bonded hard solder and hand finish flush with original machined surface. Plating is not recommended. Mask or otherwise protect surfaces from damage.

Be sure to remove brackets from main motor enclosure squarely. Avoid cocking to prevent brinnelling ball bearings or damaging flame paths at shaft openings.

**Replacement parts** for enclosure must be procured from motor manufacturer. You may replace shafts if all dimensions of original are duplicated. When reassembling motor, take special care to avoid any damage to parts and make sure that assembly is proper with adequately tightened bolts. Add grease to the joints to ease assembly, minimize later rusting of machined surface and provide a better seal against moisture. This grease should be one tested by UL at the request of the motor manufacturer and found safe for this use. Ask manufacturer which grease was recommended.

**Winding repair,** cleaning and reconditioning general procedures can be found in maintenance manuals, many other sources. For rewinding explosionproof motors, take these precautions:

(1) Use same temperature class of insulation: Change only after consulting manufacturer. Higher-temperature insulation systems may not be included in UL approval for the hazardous area involved.

(2) If thermostats or other current-interrupting devices were mounted on original winding, either remount, after checking for effective operation, or replace with duplicates mounted and insulated like originals.

In addition to adequate insulation (capable of withstanding a dielectric-test voltage of twice motor rated voltage plus 1000 volts), thermostats and other devices must be in sufficiently close contact to thermally respond and provide required protection against unsafe enclosure temperature. These devices are used on all motors for Group-C hazardous areas and all Class-H (180-C rated) insulation systems. They disconnect motor before outside of casing reaches temperatures that might ignite ethyl-ether vapor-air mixtures.

(3) When replacing leads, seal them where they leave motor enclosure in the same manner as before. Seal material must be the same as originally used, must surround each lead and be as deep as before.

**Ball bearings** which have failed, or give evidence of impending failure, must be replaced with same type. When mounting bearing on the shaft, apply pressure or blows only on the side of the inner race, using a tube squarely cut off of slightly larger bore than the shaft and slightly smaller outer diameter than the inner race. Open non-prelubricated bearings may be heated in oil to 100 C (212 F) and slid into place.

When repairing a sleeve bearing either rebabbitt it in line with usual recommendations (see article on pp 237-40) or get a new one from motor manufacturer. In any case do no work that could affect in any way the flame paths or strength of parts forming the enclosure.

**Dust-ignitionproof** motors are also used in hazardous areas. According to NEMA Standard MG1-1959, MG1-1.21, these are "designed and constructed in a manner which will exclude ignitable amounts of dusts or amounts which might affect performance or rating, and which will not permit arcs, sparks or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of specific dust on or in the vicinity of the enclosure." These motors are used in Class-II Div-1 locations which are hazardous because (NEC Sec 5005): "(1) combustible dust is or may be in suspension in the air continuously, intermittently or periodically under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures (2) because mechanical failure or abnormal operation of machinery or equipment might cause such mixtures to be produced and might also provide a source of ignition through simultaneous failure of electrical equipment, operation of protective devices or from other causes, or (3) in which dusts of an electrically conducting nature may be present."

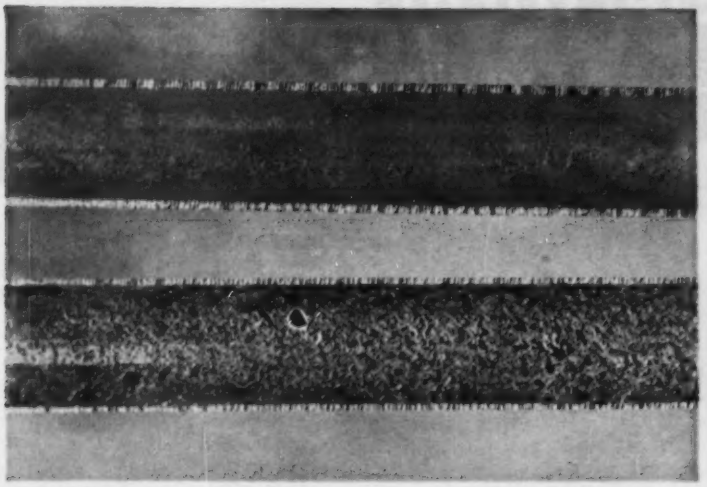
A further requirement of such motors is that they (NEC Sec 5051) "should be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of any organic dust deposits that may occur. Dust which is carbonized or is excessively dry is highly susceptible to spontaneous ignition. In general, maximum surface temperatures under actual operating conditions should not exceed 120 C (248 F)."

**Various dusts** grouped by UL on basis of hazardous characteristics in the atmosphere are listed here in descending magnitude of hazard: Group E—metal dust, including aluminum, magnesium and their commercial alloys; Group F—carbon black, coal or coke dust; Group G—flour, starch or grain dusts.

Preventive maintenance for dust-ignitionproof motors involves same procedures as explosionproof with emphasis on good housekeeping and preventing accumulations of dust on motor enclosure. Take the same precautions when repairing them, but give extra attention to restricted passages outside bearings to prevent dust entering the bearings to impair operation, or passing into the motor enclosure in quantities that might ignite.

This article is based on material originally developed by the author for Electrical Equipment Section of the National Safety Council's Program in Chicago, Oct 1959.

By T W EDWARDS
Assistant Editor



**MERCURY-INHIBITED BRASS** tube, top, compared with al-brass tube from same unit, bottom, shows reduced corrosion. Corrosion is uniform, further increasing life

**Troubled by condenser-tube corrosion and biofouling problems? These new tests indicate . . .**

# Mercury-inhibited brass tubes may help

Scaling, corrosion and biofouling of condenser tubes are continuing headaches for many utilities and industrials. This is true especially where cooling water comes from tidal sources—rivers, bays and harbors. In addition, water pollution, unfortunately varying widely with both time and location, compounds the problem. Frequently neighboring power stations and industrial plants on the same river have totally different operating experience, and a material that works well for one station may be completely unsatisfactory next door. Hence field testing in each location over a period of time is often necessary to confirm condenser-tube-material selection.

**Field tests** have been under way for several years along the Gulf Coast and in other parts of the U.S., comparing mercury-inhibited brass condenser tubes to a variety of familiar materials—admiralty, aluminum-brass, 90-10 cupro-nickel and others.

Mercury-inhibited brass condenser tubes (nominal composition: 70% copper, 30% zinc and 0.05% mercury as in Bridgeport Brass Co's Alloy 77) have physical and mechanical properties similar to arsenical admiralty. But substitution of mercury for arsenic produces special qualities because a mercury-rich film forms on tube surfaces. Material is homogeneous and this mercury-rich film associates with each grain in the metal. If surface is damaged, exposing new metal, remaining grain structure reforms the film.

**Toxicity** of mercury-rich film inhibits biofouling through its antiseptic properties, as distinguished from the sterilizing action of chlorination. As a matter of fact, where shock chlorination has been the rule it may be substantially reduced once new tubes are in. Physical character of film also retards buildup of deposits since it is difficult for them to cling to tube walls. Even after deposits have started to build up they are much more easily removed, usually by simple mechanical methods. Corrosion and inlet-end erosion-corrosion are also slowed by the mercury-rich film. Uniform corrosion in place of pitting corrosion lengthens tube life by retarding spot failure of condenser tube wall.

On polluted Neches River in E Texas, comparative tests with aluminum brass show a reduced corrosion rate. Inlet-water velocities were about 7½ fps and biofouling had been a problem. Intermittent feeding of waste caustic from the demineralizer plant controlled pH to about 8. Corrosion was uniform and approximated previous experience with cupro-nickel. In similar tests in the Tampa Bay area, the new material compared favorably over a 2-year period with cupro-nickel experience.

Mercury-inhibited brass tubes are available in regular condenser-tube sizes supplied in accordance with ASTM specification B-111, except for the chemical analysis which of course cannot apply. Like other copper-base alloys, condenser tubes of mercury-inhibited brass can be fastened to tube sheets by conventional methods.

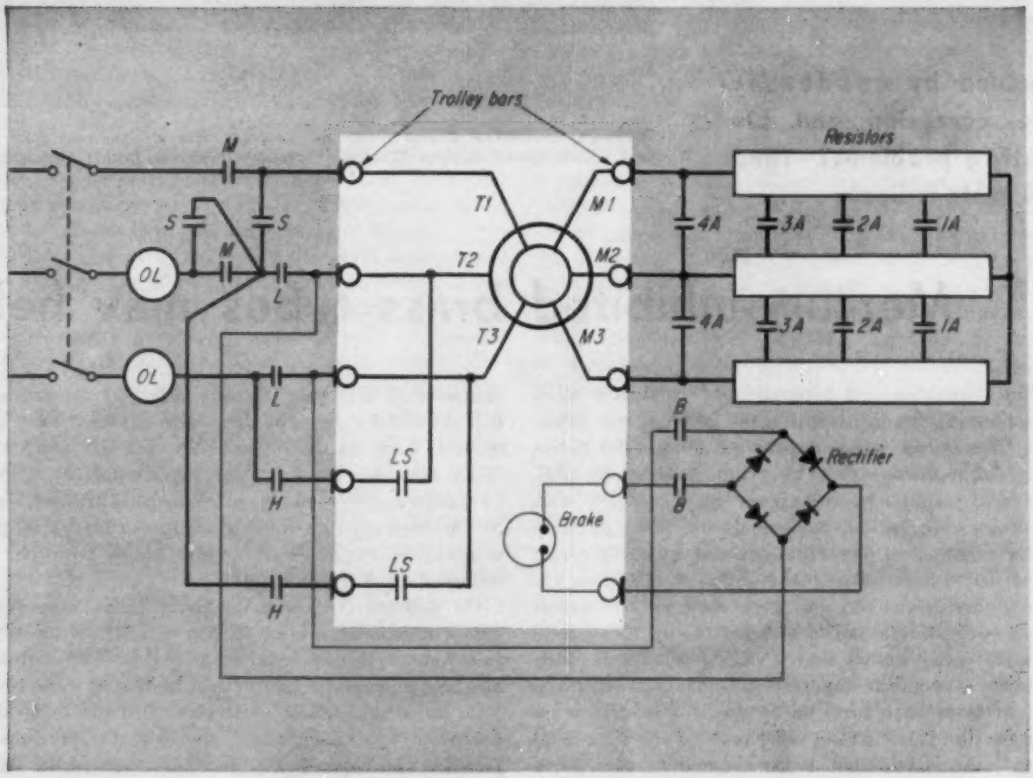
**From an economic viewpoint,** mercury-inhibited brass condenser tubes are only slightly more expensive than admiralty and considerably less expensive than any of the cupro-nickel alloys. New tubes should find wide application where problems of deposits, rapid-pitting corrosion, inlet erosion and biofouling have plagued operators. Remember, though, that field tests are the best proof, and apparently no two drops of brackish water are the same. Each location must be tested.

Plant Electrical Fact File

NO. 48: AC HOISTS

# How an ac hoist works

By NORMAN PEACH, Associate Editor

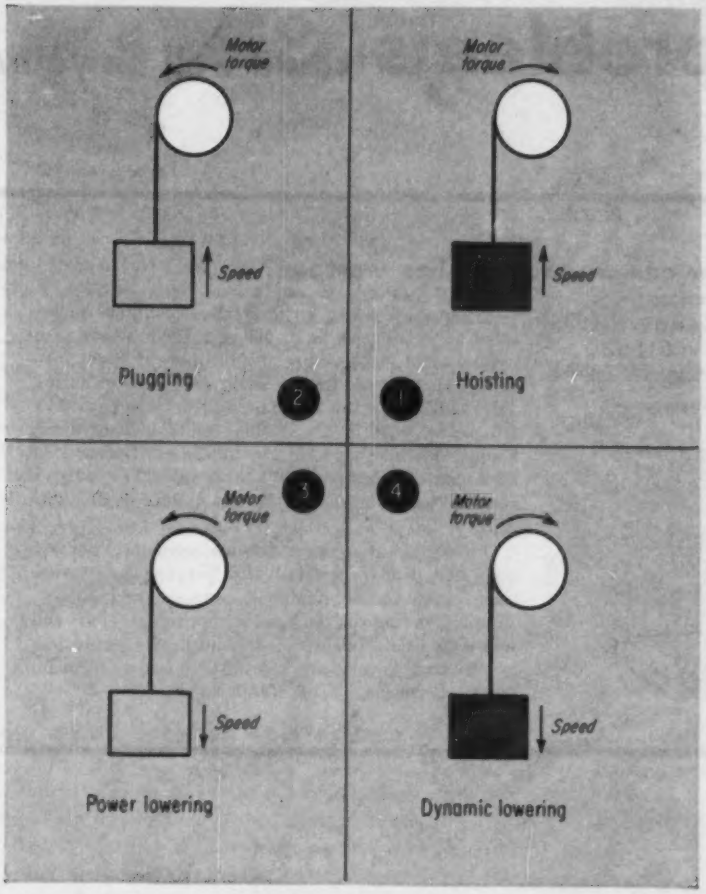



**AC HOIST** with typical ac dynamic-lowering controller is shown in main-power-circuit diagram. Wound-rotor motor, brake and limit switch mount on trolley. Ten collector rails are used. Contactors operate in sequence of diagram, right. In hoisting, *H*, *M* and brake-relay *B* close on point *1* of master switch, with all rotor resistance in. On point *2*, *1A* closes without delay and *2A*, *3A*, *4A* follow in timed sequence. If limit switch is actuated, *LS* opens to de-energize motor and set brake.

Lowering point *1* closes *L*, *S* and *A1*, joining *T1* and *T2* and applying single-phase power to *T2* and *T3*. Brake is released and motor develops retarding torque. On lowering point *2*, *S* opens and *M* closes, restoring 3-phase power, while *1A* opens for low torque for light loads. If you shift directly from *Off* to point *3*, *1A* closes immediately for more torque; *2A*, *3A*, *4A* follow in sequence

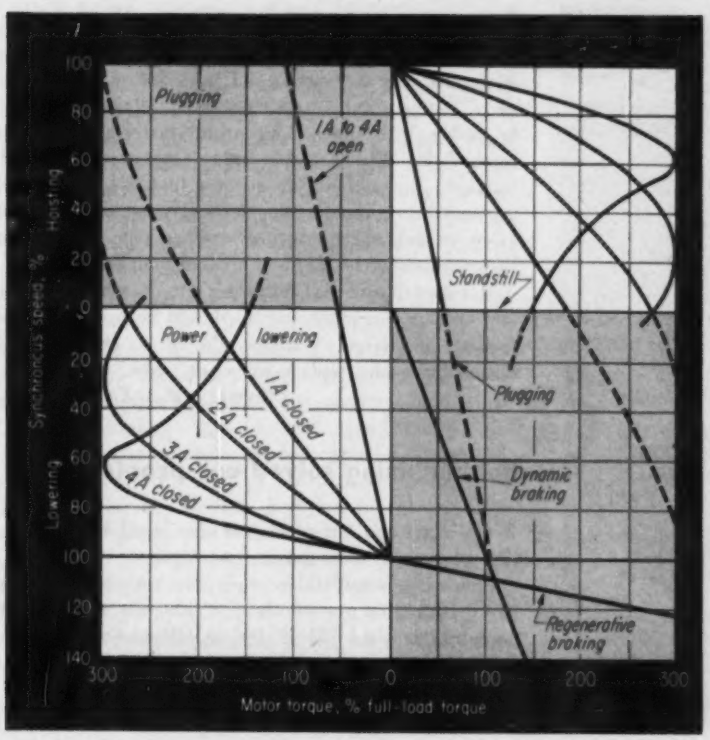
Contactor sequence

| Switch | Hoist 5 | 4 | 3 | 2 | 1 | 0 | Lower 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|
| H | ● | ● | ● | ● | ● | | | | |
| L | | | | | | | ● | ● | ● |
| M | ● | ● | ● | ● | ● | | | ● | ● |
| 1A | ● | ● | ● | ● | | | ● | | ● |
| 2A | ● | ● | ● | | | | | ● | ● |
| 3A | ● | ● | | | | | | ● | ● |
| 4A | ● | | | | | | | ● | ● |
| B | ● | ● | ● | ● | ● | | ● | ● | ● |




**HOISTING** conditions are usually represented by this type of diagram. Quadrant *1* shows power hoisting a loaded hook, motor torque applied in desired direction of movement. In quadrant *2*, plugging reverses and lowers a lightly loaded hook.

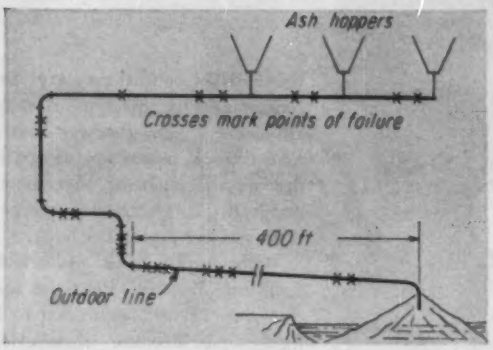
With empty hook or sufficiently light load, hoist has inertia in upward direction. Power is needed to lower light loads because of inertia and friction of hoist, as shown in quadrant *3*. Heavy loads, quadrant *4*, must be restrained from going down too fast, so braking is required. Braking generally is dynamic or regenerative—motor applies torque in direction opposite to the hoist movement




**SPEED-TORQUE** curves show behavior of ac hoist in different stages of operation. Graph is arranged in four quadrants corresponding to four operating conditions above. Plugging characteristics are shown for both directions of hoist movement. In the dynamic-lowering quadrant, on point *1* of the master switch, closing *1A* gives a retarding torque about equal to full-load torque at synchronous speed. With secondary resistance shorted (*4A* closed) and an overhauling load, motor runs somewhat above synchronous speed, producing regeneration as well as retarding torque

# These **plant problems** could well be yours...

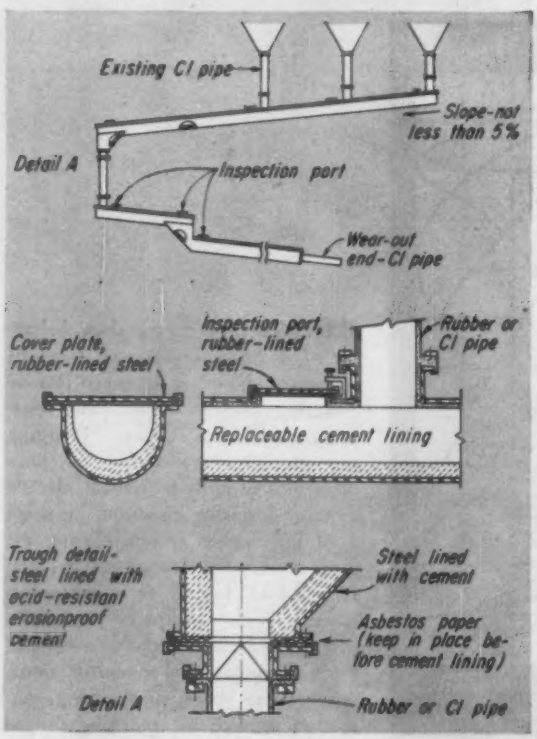
## Problem . . . How can we stop ash-line wastage?




Our plant operates four pulverized-coal-fired boilers rated at 80 mlb per hr of 600-psig 750-F steam. For normal plant loads we fire all four units at about 75% of full load. Aside from a slight drop in load during July and August we maintain fairly continuous 240-mlb-per-hr total load. All four units include flyash hoppers discharging into a hydraulic ash line and on to a settling basin. Ash line is 10-in. extra-heavy cast-iron pipe with flanged joints. Ash has high sulfur content.

Our biggest problem is ash-line wastage. Pipe sections and bends often fail after six months' service. Cause seems to be combined corrosion and erosion. Wastage occurs on bottom of horizontal runs and following bends (shown in drawing). We would like to hear from anyone who has licked this type of maintenance headache.—*SDA, March* POWER

## Solutions . . .




### Let cement and rubber take the wear

After studying the sketch and information submitted by *SDA*, I prepared the drawing at left. Details are designed to match with more appropriate materials the points marked by *SDA* as most subject to corrosion-erosion wastage. I would like to suggest that *SDA* continue to use cast-iron pipe for the vertical runs until they are all worn out, then substitute rubber pipe. Rubber has better resistance to acid and erosion than cast iron.

Horizontal runs and following curves, where corrosion and erosion are more severe, should be lined with hard cement, and large openings allowed so he can do the initial lining and replace worn-out parts.

J BORESTA, *West Englewood, N. J.*

### Rubber lining solved our problem

A few years ago our plant was also faced with the question of how to stop ash-line wastage.

Following considerable study, we corrected the problem by changing our ash-sluicing line. We switched from an extra-heavy 8-in.-ID × 9⅝-in.-OD cast-alloy pipe and fittings system to a line of standard lightweight 8-in. flanged pipe and fittings, lined with soft rubber ¼-in. thick in the straight sections, and using ⅜-in.-thick over-

# ...Here's how *Power* readers would tackle them

LAWSON STEWART, Associate Editor

lay at impact points of the system. This line is approximately 450-ft long and sluices flyash and clinkers by gravity flow to an outdoor settling basin.

The cast-alloy pipe lasted about two years under our service and required constant inspection and repairs, resulting in high maintenance costs. Rubber-lined pipe serves from five to six years, involving practically no maintenance costs. In both cases the pipe was rotated on a periodic schedule to obtain unused wearing surfaces. Fittings don't serve as long as the straight pipe because we can't change their positions to take advantage of unused wearing surfaces. Another point worth mentioning: pipe and fittings can be relined with rubber, thereby reducing replacement costs all around.

I will be pleased to answer further questions based on my experience with this subject.

C H SWANSON, *Cos Cob, Conn.*

## Take a new look at maintenance

Preventive maintenance can eliminate many ash-line failures. Life of *SDA's* present piping system could be lengthened fourfold if he would inspect, establish wear data and rotate piping for four wear sides instead of the present bottom side only. When he obtains all practical life from piping presently installed he might consider changing out to materials we have found satisfactory for this service in an extensive ash system.

*SDA* will find that pipe after his No.-1 unit doesn't wear as fast as pipe after No.-4 unit; latter transports four times the amount of material over any given period of time. We still have good piping in most lines inside our plant after six years' service. A minimum 4-year life can be expected for this type of pipe, in the portion subjected to most wear, if properly rotated. Of course, misuse can cause even new pipe to fail. A prime example: allowing line to plug by failing to flush with water after completion of the entire sluicing cycle.

Lines outside our plant are 12-in. schedule-80 carbon-steel pipe of 20-ft lengths welded together in 300-ft sections, 3500-ft overall length. The sections are joined with special couplings. Number of flanged joints was reduced to eliminate excessive erosion caused by turbulence following a coupled joint. Sections can be rotated with a utility hoist or small crane to give four wearing sides. We obtain a minimum of four years' service, and of course it's easy to weld on patches for emergency repairs.

*SDA* should eliminate as many 90-deg elbows as possible by straightening out the line, using elbows with not more than a 45-deg bend. This modification will greatly increase the wearing life of the bends which he says fail after six months' service.

M J MOSELEY, *Paducah, Ky.*

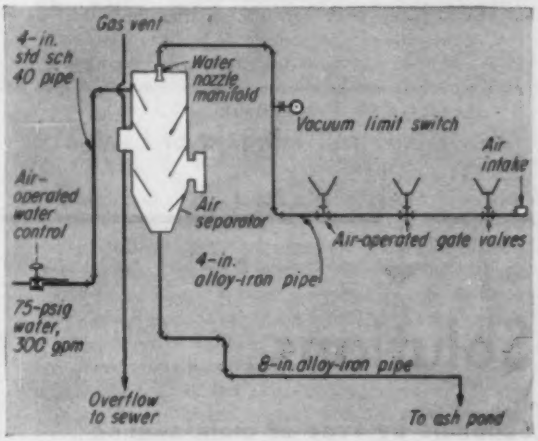
## Check limits of rubber linings

*SDA* has several precautions to observe: Handle ash in as highly concentrated a volume as possible. Velocity of ash on horizontal runs should be no slower than nine ft per sec. Remember, the wear from abrasion is less with wet than with dry abrasive—be sure to use ample water.

If above recommendations have been followed and problem continues, consult with the larger rubber manufacturers about possibility of using rubber and rubber-lined piping. Rubber-lined pipe incorporates corrosion and erosion resistance of rubber with strength of iron or steel. Or possibly synthetic-rubber linings may be of greater use if the evaluated cost is acceptable.

Repairs to rubber-lined pipe are easily made. The pipe can be made to any size and shape necessary. Only possible objection: temperature of the ash must be kept about 150 F. This can be overcome by sufficient quenching with cold water or perhaps using rubber-lined sections only at wear points indicated in the sketch. Rubber-lined piping used within limits of specifications should outlast bare piping many times over.

L E POLIKOFF, *Bethpage, N. Y.*




## Try converting to vacuum system

One of the best systems I've met appears above. It's simple, cheap to operate and low in maintenance. Briefly, here's how it works: the jet of water produces a vacuum in the 4-in. line; water leg produced in the vertical line pulls air in through the air intake, loading being controlled by the vacuum limit switch. With greater volume, vacuum increases to a predetermined value, then switch closes ash-hopper gate until vacuum drops to a set point and gate opens to start cycle again.

continued

## More **plant problems**

Only maintenance is on the removable wear-backs on each ell, which last up to two years. These can be welded with cast-iron rods, or new ones bought. Lines will last up to ten years, unaffected by any amount of sulfuric reaction or erosion. I've seen schedule-40 pipe stay in them for eight years—that is, on the ash side, not the combined material. Eliminating water in the 4-in. line also cuts out sulfuric-acid reaction.

If *SDA* doesn't want an all-new system, he can still use this type of pipe, but it should be eight in. all the way, rather than ten in. That should be large enough for his size boilers, unless ash content is far above the average 8 to 10% or oversized hoppers cut sluicing frequency.

This system will handle up to nine tons per hr. With it, he can pull his ashes in about six hr out of 24, a big saving in water alone, and a good balance of first cost.

For more info, *SDA* can write me and I'll put him in contact with the company that produces this pipe and installs the system. Installed right under their direction, it will give years of trouble-free operation.

He didn't say whether he had coarse-ash trouble. From his brief explanation I took for granted that this is fine ash. If he has a coarse-ash system as well, the two can be tied together, using 8-in. sluice lines instead of the 10-in. line. Then the ash line should be eight in., instead of four in., and he will have to use a jet pump to pump combined fine and coarse material to the pond.

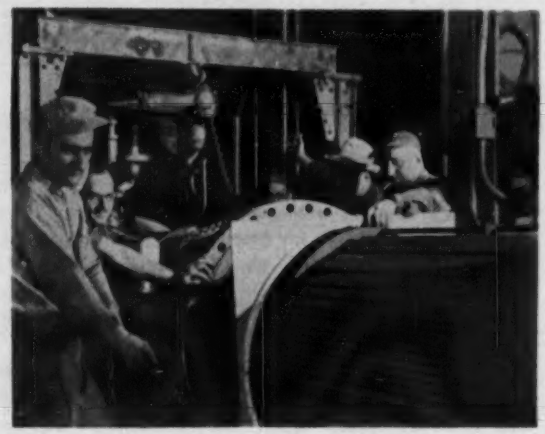
R J AVENA, *Rome, Ga.*

# Problem . . .

### What size work crew?

We would like to know if anyone among POWER's readers has ever studied relative costs of a maintenance crew of sufficient size to do all required work in a 5-day week versus a smaller crew working six days without production on the sixth day.

We do not have records to conduct such a study ourselves and hope other readers may be able to help us out.—*CAB, March* POWER



# Solutions . . .

### Schedule by type of maintenance

Maintenance must be divided into preventive and corrective maintenance. Preventive maintenance consists of inspection, lubrication, minor repair work designed to prevent outage. Much preventive maintenance can be done with equipment in operation or while machine is down for short periods—lunch hour, coffee breaks, etc.

Corrective maintenance consists of repairs to equipment shut down because of mechanical failure, removing, overhauling, installing or re-installing. Corrective maintenance usually requires more time and may have to be scheduled when plant is not in operation.

If plant operates only one shift, major maintenance may be done at night. I suggest setting up a preventive-maintenance program to be performed during the regular 5-day work week. Corrective-maintenance work (much of it of an emergency nature and therefore not subject to advance scheduling) may best be done at night with the mechanics needed working overtime.

Most wage agreements now call for premium pay for sixth-day work and some people are reluctant to work a 6-day week, so I don't believe the smaller working force would save money. To be considered in a smaller

crew is the upset of maintenance schedules caused by absences, sickness, vacations, etc. Possible solution: some crew members work the sixth day but are off the seventh and first days. This allows maintenance work six days a week, but each man works only five days.

L E POLIKOFF, *Bethpage, N. Y.*

## Construct chart from plant data

When comparing maintenance costs between a 5- and a 6-day work week, you need to know labor rates for different types of personnel. Overtime pay for the sixth day, if applicable, must also be known. Size of plant and type of maintenance are other factors that influence costs. A large installation with much equipment will require a sizable maintenance force. Type of equipment dictates class and number of personnel.

Usually, lowest-cost maintenance is available when plant is not operating. This results from non-interference by production workers and other interruptions occurring during operating periods.

I recommend that *CAB* prepare a cost estimate for each scheme. His figures should include type and number of personnel, hourly wage rate for straight time and overtime and total required hours. Table shows this info, using assumed data. By inserting applicable values, *CAB* can determine his most economical program.

H B WAYNE, *Woodhaven, N. Y.*

**5-day week**

| Personnel | No. | Rate, $ per hr | Total hr* | Cost, $ per wk |
|---|---|---|---|---|
| Foreman | 1 | 4.10 | 40 | 164.00 |
| Electrician | 2 | 3.55 | 80 | 284.00 |
| Helper | 3 | 2.40 | 120 | 328.00 |
| Pipe fitter | 1 | 3.70 | 40 | 148.00 |
| Helper | 2 | 2.55 | 80 | 204.00 |
| Millwright | 1 | 3.45 | 40 | 138.00 |
| Helper | 1 | 2.30 | 40 | 92.00 |
| Carpenter | 1 | 3.60 | 40 | 144.00 |
| Helper | 2 | 2.70 | 80 | 216.00 |
| Estimated weekly payroll | | | | 1718.00 |

**6-day week**

| | | | | |
|---|---|---|---|---|
| Foreman | 1 | 4.10 | 52 | 213.20 |
| Electrician | 1 | 3.55 | 52 | 184.60 |
| Helper | 2 | 2.40 | 104 | 249.60 |
| Pipe fitter | 1 | 3.70 | 52 | 192.40 |
| Helper | 1 | 2.55 | 52 | 132.60 |
| Millwright | 1 | 3.45 | 52 | 179.40 |
| Helper | 1 | 2.30 | 52 | 119.60 |
| Carpenter | 1 | 3.60 | 52 | 187.20 |
| Helper | 1 | 2.70 | 52 | 140.40 |
| Estimated weekly payroll | | | | 1599.00 |

Assumed normal work week: five 8-hr days. Assumed labor rate for time exceeding 40 hr: time and one-half.

*Total hours for 5-day week: 40 x number of personnel; for 6-day week: [40 + (8 x 1.5)] x number of personnel

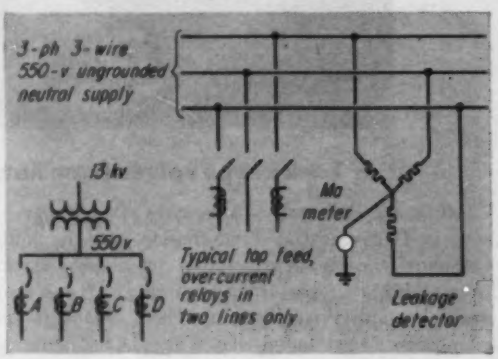
## Your June problems

### Why do our condenser tubes fail?

Our plant has had a lot of trouble with condenser-tube failures. Condenser serves a 100-mw unit and includes 85,000 sq ft of condensing surface arranged in single-pass divided-waterbox design.

Failed tubes were thinned and torn apart at the point of passing through the support baffles. Wear marks on the outside of adjacent unfailed tubes indicated tubes were cut by an external source.

Can readers give us some hint of the cause of our failures plus some way of preventing them?—*TJE*



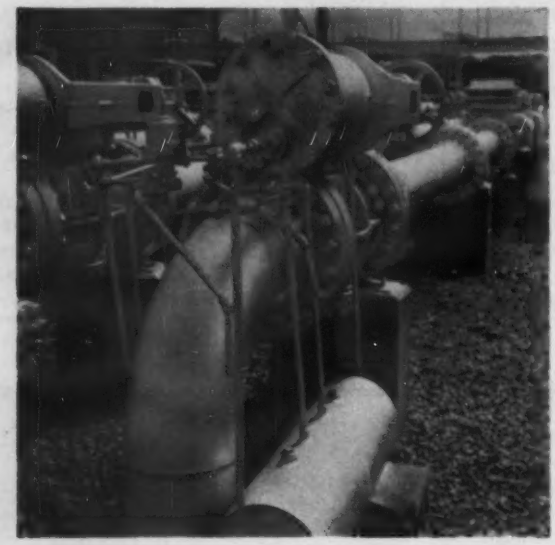

### We need to pinpoint line faults

Our electrical system is 550 v. three phase, three wire with ungrounded neutral. Motor control equipment has protective relays on just two phases, the third phase remaining unprotected. For ground-leakage detection we have a 3-phase balanced leakage detector provided on each of our main cubicles. Each detector includes three resistances Y-connected with their center point grounded through a milliammeter, circuit above. Any grounded circuit creates an unbalance through the grounded neutral and a current reading on the milliammeter.

Our central substation and all control gears of different feeders connect to a common bus, so as matters stand now, we must trip each feeder to locate the fault. Could POWER readers suggest a better system for locating subcircuit faults?—*NFA*

**Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches**

# Timely **practical ideas** to help solve



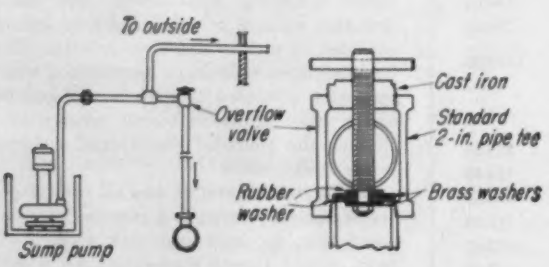
## Tank keeps valves from hammering

Controls are operated with air pressure at Tennessee Gas Transmission Company's compressor station at Greensburg, Pa. But when controls were closed they would slam. Then maintenance men found that if they used hydraulic fluid in place of the air, valves usually behaved properly.

A tank was placed at the bottom of each valve. Now air pressure works on the liquid's surface, which in turn opens or closes the valves.

Tank shown in photo has a vertical blank in the center, dividing it into two separate vessels. Compressed air is connected to tank's top and air outlet hooked up to the valve above.

H Hess, *Houston, Texas*




## I had to make a I-p valve in a real hurry

During a severe thaw followed by a rain storm, outside sewer of our small plant was so loaded that it wouldn't take discharge from the sump pump. When water started backing up through floor drain I had to do something. Sketches show our sump system and also details of a 2-in. overflow valve I made and installed to keep the sewage from backing up.

Valve is made from a standard pipe tee. Then I hooked a 2-in. section of discharge line to the outside and closed the new valve. When valve is open all the way, small rubber washer on top of the disk acts as a backup seal for the stem. Snug-fitting stem threads prevent leakage when valve is closed. This valve works well while discharging to an outside head of about five ft.

J A Fish, *Kenmore, N. Y.*

## Should thin-babbitted bearings be scraped?

One of our mechanics was fitting bearings on a truck-engine shaft. He applied Prussian blue to the shaft-journal-bearing caps fitted with new precision-bearing liners. Then he scraped the high spots on the babbitt surface of the liners.

That is not the first time I've seen mechanics fitting precision bearings by scraping the high spots from the thin babbitt of the liners. This method, as we all know, is quite right if bearings are provided with adjusting shims and babbitt is thick enough, which it usually is in slow-running engines. But using the same method with precision bearings having only a few fractions of an in. of babbitt is a delicate job.

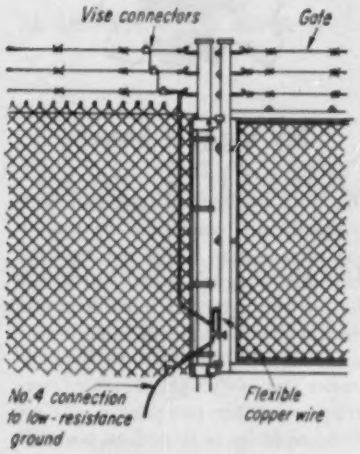
If the engine shaft is badly worn or the journals greatly out of round, I always like to send the job to a machine shop. There it is turned in a lathe to fit the undersized precision bearings. Then we bolt bearings on the shaft without scraping. In some cases, especially in remote places where I can't send the shaft to a machine shop, I file off a bit of the bearing caps together with the liners to get the right fit. I figure that liners' thinness lets them adjust and fit themselves to the journals while the engine is running.

I wonder how most Power readers do this kind of job on high-speed-engine bearings? Please write.

L B Villarta, *Misamis, P. I.*

# your tricky design and maintenance problems

STEVE ELONKA, Associate Editor




## Ground that fence!

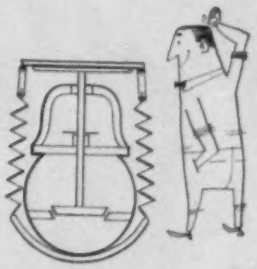
A stout security fence can be a potential killer. In hot, dry spells of summer the earth is almost nonconductive to current caused by lightning or fallen power lines. To make your fence safe, each angle, corner and opening post should be connected to a ground as in sketch. For straight sections the ground connections should be at 75-ft intervals. Use flexible copper braid in a loose loop at the hinges. This permits wide, free swinging without stress on the bridging tie.

A horizontal rail might be used instead of the usual upper strand of reinforcing wire. Then the vertical copper ground wire should be connected to the horizontal rail with a bronze connector having a $\frac{3}{8}$-in. 16 thread. Where both rail and reinforcing wire are omitted, vertical ground wire is connected to the fence mesh near its top and bottom by vise connectors, as shown above.

Moisture content affects soil resistance. A difference of a few percent, especially at moisture contents below 22%, makes a big difference in resistance. Moisture content of soil varies from about 10% in dry weather to 35% in wet seasons, averaging 16 to 18%.

Using the proper length of driven rod is important in determining resistance. Electrode should be long enough to reach permanent moisture, or seasonal changes will produce broad variations and high resistance. Bureau of Standards tests prove that the top strata, except during rainy spells and in permanent swamp areas, have greatest reduction in resistance in their first five to six ft of depth. Largest variation is between one and three ft. Change in resistance beyond eight ft is small so that an 8-ft ground rod usually will achieve permanent results in most areas.

P C ZIEMKE, *Clinton, Tenn.*



## What would you have done?

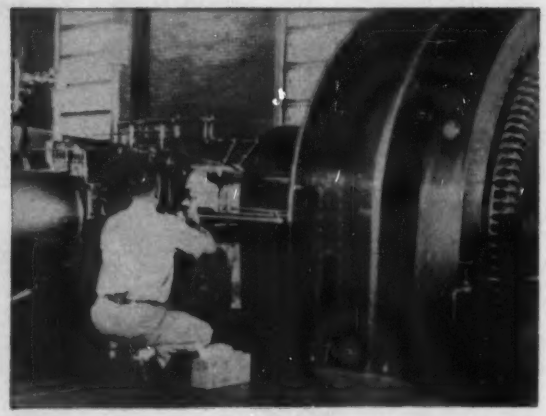
While my ship was in the yard for overhaul, an emergency shutoff valve was installed in a 4-in. high-pressure line leading from boiler to deck steam-reducing station. Specs called for a standard globe valve but a disk type nonreturn valve was mistakenly installed. No trouble arose until the ship was back at sea headed for a long voyage. Then, as deck steam flow was reduced and pressure drop across this valve became intermittent, the disk began to clatter. It clattered through the day and it clattered through the night. Sleep in nearby fo'c's'les became impossible.

We couldn't prudently close the valve because cargo steam-smothering lines took off downstream at points where pressure was supposed to be instantly available for fire fighting. The next obvious procedure was to isolate the valve temporarily, remove the disk and fling it over the side. But the piping arrangement was such that we couldn't do this without a complete shutdown. Captain was opposed to any stoppage, and the chief wouldn't insist—possibly because his quarters were at some distance from the racket.

We came up with the idea of spring-loading the valve. We first removed the yoke bushing and extended a channel iron horizontally across the valve wheel. A strong U-bolt was fitted under the valve body with heavy springs on either side, connecting to ends of channel iron. Turnbuckles provided tension adjustment. We pulled down with the turnbuckles until the valve was closed, or nearly so. At any rate, the racket ceased and we found by experiment that the valve would open by itself when flow was needed.

There was some feeling among the crew that our modified valve was in effect a cocked and loaded catapult. So there was a general nervous tendency to stay clear of it. Yet we had no further trouble or complaint during a month's trip. What would *you* have done?

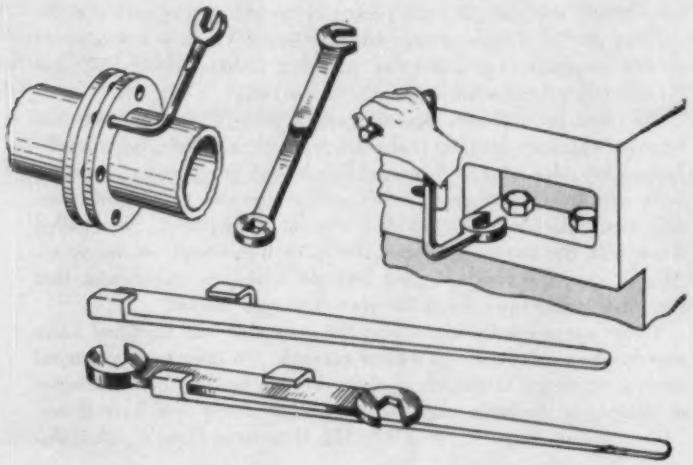
H L HUTCHINS, *Long Beach, Calif.*



## Paper wipers keep machinery sparkling

Removing spent grease from the eccentric of uniflow engine is done quickly with disposable paper wipers. Grease is wiped from the eccentric at least once every eight hours to keep it from dripping onto the floor.

We find that excess grease is absorbed by the tough, 2-ply wipers which are then discarded and burned. Paper for this purpose has proved more efficient than rags.—*Courtesy, U.S. Tobacco Co, Richmond, Va.*



## Here are some wrenches you might make

There are many types of solid wrenches on the market. Many of these were made first by the maintenance man or plant mechanic. Good idea is to have catalogs in your file to see if what you need is on the market. It's cheaper to buy your wrench.

But not all the wrenches you need are made commercially. My sketches show some ideas that are worth the effort to make. In these days of welding it's easy to convert standard wrenches to special uses as shown.

C H Willey, *Penacook, N. H.*

## My biggest boner

Our 5000-bbl fuel-oil tank had been gradually surrounded by the reserve coal-storage pile. So we had to move the tank. Rigging gang looked over the job and agreed to move it in one piece if they could weld some braces inside. Tank was about 35 ft in diameter and 30-ft high, of riveted construction. After pumping it out we found eight in. of sludge, an accumulation of 20 years. It was bailed out and we removed heating coils. We steamed the tank to make it clean and gas-free for welding operations.

Leaving both 24-in. manholes open, we turned steam on the open heating-coil connections. But as air circulated freely through the tank, steam did little good. After 24 hr we put back both manhole covers. A day later there was a small plume of steam coming out of two 2-in. vent lines. I decided to steam her for another two days, told shift engineer to shut steam off at midnight Saturday so tank would be cool Monday morning.

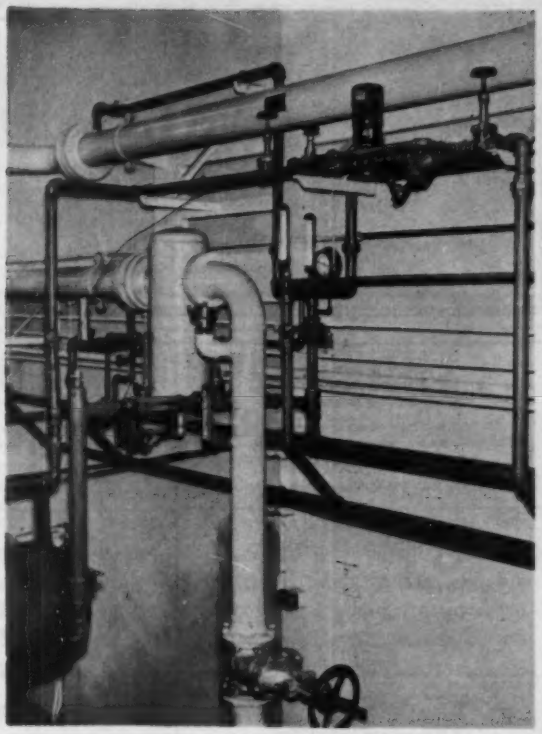
Pressure dropped during cool nights. Only holes open into tank were the two vent lines. These let in cool air which condensed the water vapor. About four am tank's sides couldn't hold against the vacuum. Walls caved in like the tin can used for vacuum experiments in a physics lab. We had to fill tank with water, calk rivets and add one patch to get her back in shape.

What would have happened if we removed the manhole covers when we shut off the steam? Would the cool air have condensed the steam fast enough to pull a vacuum if we had taken off only the top cover? What if we'd removed both covers? Real boner was assuming that an API tank, built like a tin can, could hold internal pressure like a ship's tanks.

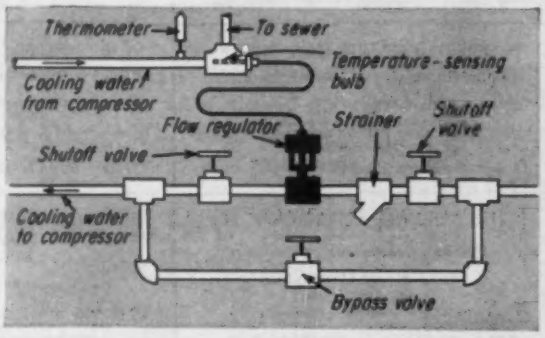
J L Aikman, *Montreal, Can.*

**This is how Boeing Airplane plants in Seattle area alone...**

# Save $50,000 a year by water conservation



**SMART HOOKUP** of cooling water to air compressor thermostatically controls outlet water so temperature stays around 110 F




**PIPING** diagram shows all essential valves and instruments used on air-compressor cooling system to save maximum amount of water

Water used by Boeing Airplane Company plants in the Seattle area during 1958 cost $271,000. Smart conservation here adds up small economies to produce overall annual savings running about $50,000.

**Cooling towers,** water-storage tanks and other reuse systems are all part of the picture. Sewer charge is based on water consumption; by cutting down purchased water, company automatically trims the sewer bill as well.

Degreasers, presses, spot welders, refrigerator compressors, vacuum pumps, air compressors and X-ray machines are equipped with solenoid water-control valves. Most of this equipment has little heat-storage capacity, so solenoid valves are often provided with bypasses or time delays to permit cooling after the power shuts off. If usage is normally intermittent, solenoid valves are installed wherever possible.

**Thermostatically controlled** water-regulating valves are mostly used on air compressors, some refrigeration compressors, wind tunnels, air conditioners, large presses, autoclaves, some furnaces and ovens, vacuum pumps. Cooling towers process water for air compressors, air conditioners and wind tunnels.

**Manual control** still handles a few items of equipment, but, naturally, trend is to put in automatic controls wherever it can be done. Large furnaces, ovens, gas generators and certain test equipment, where operator stands by, carry manual water-control valves.

**Process water** is used in chemical tanks, rinse tanks, quench tanks, photo template apparatus, paint booths, wash racks and booths, chemistry labs and boilers. Process-water consumption is mostly controlled by hand, although some float, pH and thermostatic controls are used on makeup for rinse, chemical and quench tanks.

As the hot weather sets in, company begins appeals to conserve water for personal use. In management bulletins and company publications, employees are asked not to tie drinking fountains wide open. Point is that water stays just as cool if the fountains are not cracked open. Each of scores of drinking fountains would use $40 worth of water per year if the fountain ran free, so they figure this campaign saves an annual $2000.

**Continuing effort** towards utility conservation features monthly audits and cost analysis. Unusual specific costs are tracked down by company's plant-services engineering dept. They study needs and problems, make recommendations to the facilities-engineering dept.

Water conservation is a year-'round program with Boeing, designed to determine specific water requirements, make users aware of these needs and control consumption through instruction, piping changes, restrictions, and installation of thermostatic control valves, solenoid valves and cooling towers. Benefit? The $50,000 saving.

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*For the solution of your problems, consult the Professional Services Section of Power.*

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## San Francisco
## or
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Power and Industrial Division offers immediate employment opportunities for electrical, mechanical, or structural engineers capable of assuming responsibility on design of major steam or hydro power plants.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. If you have an interest in a San Francisco or Los Angeles assignment, please send a resume of experience, including a statement of present earnings and new salary requirements, to George I. Copeland, Manager of Personnel. Personal interviews will be arranged for qualified candidates.

**Bechtel**
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Paul Keating, MUrray Hill 7-7100

**Machinery Wanted:**

2—Package Boilers 600 H.P. each—150-200 lbs. operating pressure—oil or coal fired—A.S.M.E. Coded for installation New Jersey plant.

W-4352, POWER
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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NEW OR EQUIVALENT TO NEW
60,000 to 70,000 KW
**ELECTRIC GENERATOR SET**
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WE PAY
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ALLIED ELECTRIC CO.
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for your new surplus motors, controls and transformers!
AVAILABLE: NEW MOTORS
Over 5,000 new motors in stock from ½HP to 200HP. Special low prices

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**AJAX** ELECTRIC MOTOR CORP.
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We are a fast-growing paper manufacturer located in northeastern Wisconsin. Our engineers handle interesting work with a lot of variety and plenty of opportunity to use their own discretion and judgment. Because of our rapid growth, we do not have time to increase our engineering staff by hiring new graduates and training them. We are interested in recent graduates but we also want to find experienced men who can produce quickly. If you are an ambitious engineer in either category and want to get ahead faster and farther than your present job permits, this may be just the opening you are looking for. We need qualified men in the following fields:

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In addition to excellent starting salaries, we offer a well-rounded employee benefit program with group life and group hospital and surgical insurance paid for by the company and an outstanding profit-sharing retirement plan. If you are interested, please write us, giving your complete personal and business history, which will be held in strict confidence.

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**Mechanical Engineers. Excellent opportunity for** Project Managers, Project Engineers, and Design Section Chiefs experienced in design of heating, ventilating, air conditioning, piping, power plants. Extremely wide variety of work (including client contact) with established Midwest consulting firm. Permanent. Good starting salary, advancement and vacation program. Moving expenses paid. All replies will be answered. P-3214, Power.

**Design (Mechanical) Engineer with experience** in design of boiler plants, coal and ash handling systems, economic studies for industrial and utility plants. Must be able to write clearly and concisely. Location East. Send complete resume including salary requirements to P-4006, Power.

## POSITIONS WANTED

**Power Plant Engineer, age 38, technical education,** 8 yrs. experience as chief engr. in the operation, maintenance, management, and plant betterment. PW-3449, Power.

**Position desired—Maint. supervisor or Foreman,** age—47, Technical Education, Experience—25 years of power plant maintenance and operation of both high and low pressure systems. Ten years in supervisory capacity. PW-4388, Power.


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B. C. Electric Company requires a Deputy Station Superintendent by July 1, 1960 for its thermal generating plant, now under construction, which will have an ultimate capacity of 945 megawatts.

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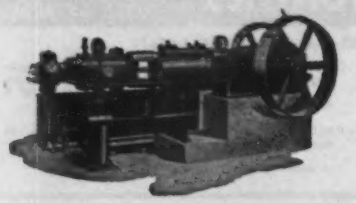
# THE COMPRESSOR LINE



## HIGH PRESSURES

26.8 CFM 3000 psi Worth. V4A3
97 CFM 1500 psi 6½—3¾—1⅝ x 7 CP TCB 3
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150 CFM 3000 psi 13¾x12 Norwalk TRS4T
311 CFM 1500 psi 10½—7⅛—5½ x 18 IR ES3
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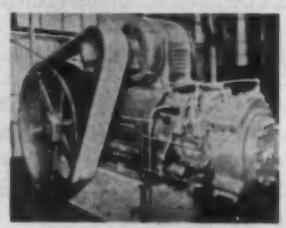
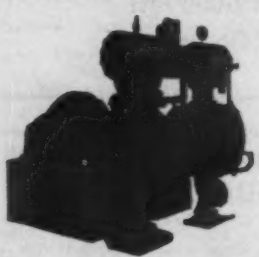
2500 CFM 50 PSI 10-19x14 Pennsylvania DE-1 direct connected 300 HP Synchronous 2/60/2300 volts, M-G set and controls. Excellent.



Unused 9x9 Worthington HB with unused accessories complete—40 HP motor, starter, 24"x8' ASME Air Receiver, Aftercooler, Separator over-head V-U-Drive, and filter. SPECIAL $3975.00.



1545 CFM Displacement 80-110# 277 RPM 250 HP Motor Req'd. 21/13 x 14 Ingersoll-Rand XRE two stage, double acting, duplex, water-cooled, heavy duty, horizontal, synchronous motor driven air compressor equipped with: Step control, Mechanical force feed cylinder lubrication, Automatic frame oiling system, Intercooler with safety valve and pressure gauge, Air intake filter. DIRECT CONNECTED TO: 250 HP Eletric Machinery 277 RPM 80% power factor 3/60/440 volt engine type synchronous motor complete with automatic starter & MG Set.

**VERY EXCELLENT — ON FOUNDATION**

**For any size or make compressor try American Air.*

# AMERICAN AIR COMPRESSOR CORPORATION

Dell Ave. & Power St. North Bergen, N. J.
UNion 5-4848

Circle 504 on Reader Service Card

# CONVERSION & POWER EQUIPMENT

## M-G SETS—3 Ph. 60 Cy.

| Qu. | KW | Make | RPM | DC Volts | AC Volts |
|---|---|---|---|---|---|
| 1 | 4000/4800 | G.E. (SU) | 450 | 250/300 | 2300/4600 |
| 1 | 2500 | Whse. (SU) | 720 | 600 | 2300/4600 |
| 1 | 1750/2100 | G.E. | 514 | 250/300 | 2300/4600 |
| 1 | 2000 | G.E. | 514 | 600 | 2300/4600 |
| 1 | 1500 | G.E. | 720 | 600 | 6600/13200 |
| 1 | 1500 | Cr.-Wh. | 720 | 300 | 2300/4160 |
| - | 250 | Whse. | 720 | 600 | 2300/4160 |
| 1 | 1000 | G.E. | 720 | 250 | 2300/4160 |
| 1 | 1000- | G.E. | 900 | 300 | 4000/6600 |
| 1 | 500 | G.E. | 900 | 125/250 | 440 |
| 1 | 500 | G.E. | 900 | 250 | 2300/4000 |
| 1 | 500 | G.E. (new) | 1200 | 300 | 2300 |
| 1 | 400 | C.W. (SU) | 1200 | 125/250 | 2300 |
| 1 | 350 | G.E. | 900 | 125 | 440/4160 |
| 2 | 300 | G.E. | 1200 | 250 | 2300 |
| 1 | 300 | Whse. | 1200 | 600 | 2300/4160 |
| 1 | 300 | G.E. | 1200 | 250/275 | 440 |
| 1 | 200 | G.E. | 1200 | 250/275 | 2300/4160 |

## MERCURY ARC RECTIFIERS

| Qu | KW | Make | Type | DC Volts | AC Volts |
|---|---|---|---|---|---|
| 1 | 150 | G.E. | RP 30 | 265 | 308 |
| 1 | 150 | G.E. | 6RP | 275 | 2300/4160 |

## FREQUENCY CHANGER SETS

| Qu. | KW | Make | Freq. | Voltages |
|---|---|---|---|---|
| 1 | 5000 | G.E. | 60/50/60 | 11000/6600 |
| 1 | 2500 | G.E. | 25/62½ | 2300/2300 |

## TRANSFORMERS

| Qu. | KVA | Make | Type | Ph. | Voltages |
|---|---|---|---|---|---|
| 3 | 2333 | Whse. | OISC | 1 | 13800x2300 |
| 1 | 3000 | A.C. | OISC | 3 | 84500x2300 |
| 3 | 1000 | G.E. | OISC | 1 | 13800x460 |
| 3 | 833 | A.C. | OISC | | 12200x2300 |

## TURBO GENERATORS

| Qu. | KW | Make | Description |
|---|---|---|---|
| 1 | 1000 | G.E. | Non Cond. 125#/5-15# R.P. 2300V. |
| 1 | 3000 | G.E. | Cond. 400#-750° 2400/4150V. |
| 1 | 4000 | G.E. | Cond. 400#-750° 2400/4150V. |

## A.C. MOTORS — 3 Ph. 60 Cy. Slip Ring

| Qu. | HP | Make | Type | Volts | Speed |
|---|---|---|---|---|---|
| 1 | 1750 | G.E. | M-570RS | 4800/2400 | 1800 |
| 1 | 1500 | G.E. | MT-6 | 6900/4000 | 1197 |
| 1 | 800 | Whse. | CW | 550 | 1775 |
| 1 | 800 | G.E. | MT-428 | 2200 | 450 |
| 1 | 600 | Whse. | CW-32D-15 | 440 | 1775 |
| 1 | 600 | Whse. | CW | 440 | 850 |
| 1 | 550 (Unused) | Whse. | CW | 440 | 392 |

## SQUIRREL CAGE

| | | | | | |
|---|---|---|---|---|---|
| 1 | 550/275 | Whse. | CR-1115 | 2200 | 450/900 |
| 1 | 500 | G.E. | FT-550Y | 2300 | 3600 |
| 3 | 300 | Whse. | CSP-583H | 440 | 3600 |
| 4 | 500 | Whse. | CR-1216 | 2200 | 500 |
| 2 | 450 | Elliott | 3010 | 2200 | 1185 |
| 1 | 400 | Whse. | CR-7151 4000/6600 | | 3600 |
| 1 | 300 | Whse. | CR-1002 | 2200 | 600 |
| 1 | 200 | G.E. | RT-589A | 2300 | 1775 |

## SYNCHRONOUS

| | | | | | |
|---|---|---|---|---|---|
| 1 | 7000 | G.E. | TS-8407 | 2300/4000 | 360 |
| 1 | 5300 | G.E. | ATI | 2200/6600 | 600 |
| 3 | 1750 | G.E. | ATI | 2200 | 3000 |
| 1 | 1750 | G.E. | TS | 2300 | 900 |

**RE-NU-BILT BY**

# BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

Tel: OLDFIELD 3-3334

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## FOR SALE
## 14 NEW TURBINES

**4 horizontal, 10 vertical, Westinghouse**
Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired.
*Price reasonable.*
*Also*—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volts. Used one year.

**G. M. De ROSE**
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## NEW EQUIPMENT FROM THE UNCOMPLETED
# BATTLESHIP U. S. S. KENTUCKY

*Installed but never used*
*Built of finest materials*

**WESTINGHOUSE 1250 K.W. TURBO-GENERATORS**

(4)—Westinghouse—440/3/60—850°—540 lbs. working pressure. Complete with condensers, circulating pumps, etc.

**MAIN CONDENSERS**

Mfg. by Foster-Wheeler—23,500 sq. ft. cooling surface—40,500 GPM circulating water—total tubes 8,976, or cupro-nickel, as follows: (550) each ⅝" x 0.065 and (8416) each ⅝" x 0.049. Monel water boxes.

**BOILERS**
**7 B&W EXPRESS TYPE**

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity: 210,000 lb.* steam/hr. ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters. Can be converted for #2 oil and natural gas. Fully automatic.

**LARGE DEAERATING FEED HEATERS**

Monel construction—spray type—capacity 480,000 lbs./hr.—vent condenser—single pass —heating surface 174 sq. ft.—all Monel construction.

**GE HIGH AND LOW PRESSURE MAIN PROPELLING TURBINES**

Will sell separately for testing, wind tunnel or similar work. (2) high pressure—24,400 HP—12 impuse stages—4909 RPM—working pressure 540 lbs.—825°F. (2) low pressure—28,600 HP — 3913 RPM — working pressure 49 lbs. steam—424°F—2-6 stages of impulse.

**THE BOSTON METALS CO.**
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 507 on Reader Service Card

1—Gardner-Denver air compressor, 445 cfm @ 100# pressure, 6 cylinder, 2-stage, 1952. Req. 100 HP.

2—B. Kocler 200 HP water-tube boilers, 100 psi, Stoker fired, 1945.

1—Babcock & Wilcox #32E coal pulverizer, air swept, 75 HP.

*WRITE FOR DETAILS*

**PERRY EQUIPMENT CORP.**
1422 N. 6th St., Philadelphia 22, Pa.
Phone: POplar 3-3505

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## DIESEL ENGINE GENERATOR UNIT

575 HP, 600 RPM, Worthington Type DH-6 Diesel engine direct connected to 500 KVA—400 KW, 80% PF, 600 RPM, 3 phase 60 cycle, 240/139 volts Electric Machinery synchronous generator complete and equipped with exciter, switchboard with instruments, attached and unattached auxiliaries to the engine. Slightly used—practically new. Immediate delivery.

**UTILITIES MACHINERY CORPORATION**
1965 East Sixth Street, Cleveland 14, O.

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# COMPLETE MODERN 400 LB. POWER PLANT

## 3750 KVA Elliott Turbine Generator—563 H.P. Wickes Boiler 475 PSIG W.P.

**Turbine is 440 PSIG 750° FTT Generator is 3/60/2400/4160. Surface Condenser and all auxiliaries.**

This plant is complete in all respects and can be inspected as originally installed. Photographs, prints and specifications available

Other turbine Generators

| | |
|---|---|
| 1-1500 KW Westinghouse | 600# 750° Non-Cond. 150# BP 2400V |
| 1-2000 KW GE | 600# 750° Non-Cond. 150# BP 4160V/6600V |
| 2-3000 KW GE | 600# 750° Non-Cond. 150# BP 2400/4160V |
| 1-2500 KW Allis Chalmers | 400# Autext 150° Non-Cond. 30# 480V |
| 1-2500 KW Westinghouse | 125# Non-Cond. 10# BP 2300V |
| 1-2500 KW GE | 400# 750° Autext 25# Condensing 600V |

Coble Address: CHASWEAVER

**CHARLES WEAVER, INC.**

19701 JAMES COUZENS HIGHWAY

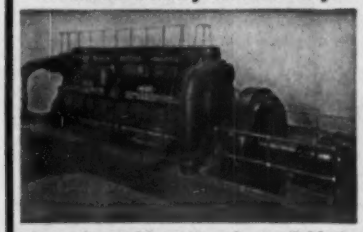
DETROIT 35, MICHIGAN

Telephone: BRoadway 3-1900

Circle 510 on Reader Service Card

## DIESEL ENGINE GENERATOR SETS

**Immediate Delivery from Inventory!**



Any voltage; 50 or 60 cycle. Available in stationary, mobile or portable model. Following listing is only partial.

2000 kva Fairbanks-Morse model 33F16 (photo above)
1420 kva Fairbanks-Morse model 38D—8⅛
1375 kva General Motors model 278A
1250 kva General Motors model 567
938 kva General Motors model 567
625 kva General Motors model 278A
625 kva American Locomotive Co. model 539
412 kva Worthington model CC
375 kva General Motors model 268A
312 kva General Motors model 268A
250 kva General Motors model 268A

**A. G. SCHOONMAKER** Company, Inc.

Foot of Spring St., Sausalito, Cal. Edgewater 2-1490

50 Church St., New York 7, N. Y. Digby 9-4351

Circle 512 on Reader Service Card

## UNUSED—ASSEMBLED—NEW

**IN ORIGINAL MANUFACTURER'S PACKING CRATES**

**BOILERS (Package type)**

B&W—60,000 lbs./hr.—475 psig., 740°TTF, oil fired (shipped intact as one integral unit)
B&W—122,500 lbs./hr.—635 psig., 850°TTF, oil fired (unassembled)

**TURBOGENERATORS**

4800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/93.3/2700V PF 1.0—New
1800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/60/1735 V PF 0.8—New
1000 KW GE Turbine—Gen Set, Cond 200psi, 600°TTF, 28.5 Hg exh, 3/60/2400V PF 0.8

**STEAM TURBINES**

1000 SHP GE Cruising Cross Compound, 525psi, 825°TTF, 81psi exh, 10,119/330 RPM with Falk reduction gears—New
3000 SHP GE HP Main propulsion turbine 410psi, 9040RPM, 725°TTF } 1 Set—New
3000 SHP GE—LP Main propulsion turbine 40psi, 9040RPM
11,550 SHP GE HP 12 Stage Cross compound turbine 525 psig, 825°TTF 5870RPM } 1 Set—New
13,450 SHP GE LP 48psig, 4714RPM with Westgh speed decreaser gear assy.
294 HP Worthington-Moore, Non-Cond. Form #S2R, 310psig, 650°TTF, 2psi-exh, 3560RPM

**PUMPS, CENTRIFUGAL (Motor driven)**

283 GPM @ 375'TDH, Ingersoll Rand—2GT, w/60HP 3525RPM 3/60/220/440V (Used)
275 GPM @ 635'TDH, Ingersoll Rand—2GT, w/75HP 3525RPM 2/60/2300V (Used)
200 GPM @ 1300'TDH, Ingersoll Rand—½CNTA, w/Base, Motor optional

**PUMPS, CENTRIFUGAL (Turbine driven)**

480 GPM @ 750psi discharge, Worthington, w/350HP turbine, 575psi, 4900RPM—New

**BLOWERS, TURBO-CENTRIFUGAL**

20,000 CFM @ 17"WC, Westinghouse, Vaneaxial, w/Turbine, 82.5HP, 375psi, 10psi—exh, 4625RPM—New
24,000 CFM @ 26"WC, Sturtevant Co, Rexvane, w/Turbine, 191HP, 400 psi, 10psi—exh, 3525RPM—New
43,000/50,000 CFM @ 8"/11"WC, Sturtevant, Turbovane, w/Turbine 98/141HP, 400psi, 10psi—exh, 4980/5870RPM—New

**WABASH POWER EQUIPMENT CO.**

**9750 SKOKIE BLVD., CHICAGO (Skokie), ILLINOIS**

TEL. OR. 3-8118

Circle 511 on Reader Service Card

# POWER EQUIPMENT DIVISION

## GENERATOR SETS

11—1250 KVA Natural Gas Engine Sets 3/60/2400/4160 with switch gear (can be seen running)
1—500 KW Condensing 200 PSI Turbine
1—500 KW G.E. Non Cond. 265 PSI
0-10# BP Turbo Generator

## TRANSFORMERS

1—6000 KVA 3/60/44000—4160 Substa.
3—500 KVA 1/60/66000— 480
6—450 KVA 3/60/13800— 460
3—333 KVA 1/60/2300/4160 Y—480

## STEEL BUILDINGS (16)

46' w. x 741' l. x 27'4" under chord
Will sell in multiples of 19'.

## CRANES

40/10 ton OET 47'3" Span 75' Lift AC
25 ton Powerhouse 36'6" Span AC
6 ton OET 43' Span 20' Lift DC

## BOILERS

40,000#/hr. 225 PSI B&W Type F22
25,000#/hr. 450 PSI @ 738°F. Stirling
18,000#/hr. 160 PSI Keeler
NEW UNASSEMBLED B&W, F.W., C.E. complete with Superheater, Economizer, Soot Blowers, Oil Burners, Steel Encased
122500#/hr. 565 PSI 850°F.
44500#/hr. 450 PSI 735°F.
35000#/hr. 285 PSI 577°F.

**HEAT & POWER CO. INC.**
60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

Circle 513 on Reader Service Card

# DEAERATING FEED TANKS

2—Cochrane vertical cylindrical deaerating feed tanks of STAINLESS STEEL CONSTRUCTION. Upper section: 8'-3" I.D. by 3'-7" high outside, contains direct contact feed water heater, an internal deaerating atomizing valve assembly, an external valve control unit, and a tubular surface type vent condenser. Lower section: 10'-6" I.D. by 8'-2" high outside and used for storage of deaerated boiler feed water. Delivered capacity 414,500 pounds per hour feed water maximum rating. For price or additional information, contact:

**RALPH E. INGRAM**
**ZIDELL EXPLORATIONS, INC.**
3121 S.W. Moody Ave., Portland 1, Ore.
CApitol 8-8691

Circle 514 on Reader Service Card

# ELECTRICAL POWER EQUIPMENT

## SLIP RING MOTORS

3 ph 60 cy 220 or 440 volts

| HP | RPM | MAKE | TYPE |
|---|---|---|---|
| 1500 | 514* | Al.-Ch. | Mill Type |
| 1300 | 300* | Al.-Ch. | Mill Type |
| 900 | 166* | Al.-Ch. | Mill Type |
| 600 | 1800* | Gen. Elec. | M-63438, Dppf. Now |
| 500 | 1200 | Gen. Elec. | M-63465Z, Dppf. |

*2200 volts or higher

## SQUIRREL CAGE MOTORS

3 ph. 60 cy. 220 or 440 volts
(*2200 volts or higher)

| HP | RPM | MAKE | TYPE |
|---|---|---|---|
| 1250 | 3600* | Al.-Ch. | ANX |
| 800 | 1800 | West. | CS84C |
| 600 | 600* | West. | CS-14-C15 Dppf (2) |
| 500 | 1200 | G.E. | I-K |
| 400 | 1800* | L. Allis | BB, Sppf. |
| 400 | 1800 | West. | BB. Dppf. |

## MOTOR GENERATOR SETS

| KW | Make | Motor A.C.V. | Generator D.C.V. |
|---|---|---|---|
| 1000 | West. | 4160 | 250 |
| 600 | G.E. (3 unit) | 2300/440syn. | 125/250 |
| 500 | West. | 2300/440syn. | 125/250 |
| 400 | Al.-Ch. | 2300/440syn. | 125/250 |
| 300 | West. | 2300/480syn. | 250 |
| 200 | Rel. | 2300/440syn. TS | 500 |
| 200 | G.E. | 2300/440syn. TS | 250/375 |

## TRANSFORMERS

*Special Offer — Like New*

3—1250 KVA Allis Chalmers Class OA Oil filled 3ø1 ph 60 cy 34,000 Volt primary, 480 volt secondary with taps, manufactured 1955.

Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

Our 50th Year 1910 to 1960

Phone CAnal 6-2900

**CHICAGO Electric Co.**

1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 516 on Reader Service Card

# DUAL FUEL DIESEL ENGINE GENERATOR UNITS

1050 KVA Nordberg supercharged dual fuel diesel engine generator unit 3 phase 60 cycle 2400 volts 327 RPM. New 1947—Excellent condition.

1250 KVA Worthington supercharged dual fuel diesel engine generator unit 3 phase 60 cycle 2400/600/480 volts 360 RPM. New 1949—Excellent condition.

1420 KVA Fairbanks Morse opposed piston diesel engine generator unit 3 phase 60 cycle 2400 volts 720 RPM. New 1950—Excellent condition.

The above units are still installed and complete with all auxiliaries as in operation.

**INTERNATIONAL POWER MACHINERY CO.**
1612 Union Commerce Bldg. — MAin 1-9514
Cleveland 14, Ohio

Circle 517 on Reader Service Card

## MODERN G.E. RECTIFIERS

6—1000KW Mod. 6RC-45-CD6 Auto. Subs.
2— 500KW Mod. 6RG-45-CH2 Auto. Subs.

1948 Vintage still like NEW condition. Can be inspected under power at Birmingham. Priced at $35. per KW (Less than ½ replacement).

S. M. DAVIS Box 1497, E. St. Louis, Illinois

Circle 518 on Reader Service Card

**New and Used Equipment Available for**
**POWER PLANTS, SUBSTATIONS, TRANSMISSION LINES AND CONSTRUCTION**
*Send for new list*
**EBASCO SERVICES INCORPORATED**
APPARATUS EXCHANGE Two Rector St., New York 6, N. Y.

Circle 515 on Reader Service Card

FROM AIRCRAFT CARRIER "ENTERPRISE"

# [4] 1000 KW GEARED TURBO-GENERATORS

*For Condensing or Non-Condensing*

**1000 KW TURBO-GENERATOR COMPLETE WITH CONDENSERS CIRCULATING PUMPS CONDENSATE PUMPS AND SWITCH GEAR**

GENERATOR: 1000 KW — type ATB-2 — G.E. — form H.L.—1250 KVA—3/60/450—1925 amps—3600 RPM—0.8 P.F.—field amps 67—typical serial No. 5358286—with 120 volt 11KW DC exciter—compound wound.

STEAM TURBINE: 1000 KW G.E.—type FSN-4R-FN30-8STG—rated 7964 RPM—exhaust 1 lb. absolute when condensing.

REDUCTION GEAR: S-11B—form A—RPM 7964/3000.

TURBINE STEAM PRESSURE: 375 lbs—178°F superheat—exhaust pressure 1 lb. absolute when condensing. Can be used condensing or non-condensing. Can be operated at reduced pressures.

*BUILT AS MARINE UNITS USING FINEST MATERIALS. DRIP - PROOF CONSTRUCTION. UNITS ARE 16' LONG — 7'8½" WIDE. MOUNTED ON PRE-FAB SUB-BASE.*

**THE BOSTON METALS CO.**
313 E. Baltimore St. Baltimore 2, Md.
ELGIN 5-5050 LEXINGTON 9-1900

Circle 519 on Reader Service Card

# DIESEL GENERATOR SETS

1—1420 KVA F.M. 3/60/2400 1945
1—625 KVA Superior 3/60/2300, 1950
1—375 KVA Caterpillar Portable 3/60/2300, 1953
1—375 KVA GM—8—268—3/60/480, 1945
1—250 KVA F.M. 3/60/220/440/300 RPM, 1947
1—187 KVA G.M. Portable 3/60/220/440, 1953
1—156 KVA Cummins Portable 3/60/220/440, 1956
1—125 KVA Cummins Portable 3/60/220/440, 1956
1—118 KVA F.M. 3/60/2300/360 RPM
1—75 KVA Hercules Portable 3/60/220/440
2—37½ KVA G.M. Portable 3/60/220/440
20—12½ KVA Willys Gas 1/60/115/230
10—6.25 KVA Ford Gas 1/60/115

**THE O'BRIEN MACHINERY CO.**
1915 W. CLEARFIELD STREET
PHILADELPHIA 32, PA.

Circle 520 on Reader Service Card

# POWER EQUIPMENT

6000 KW, G.E. Cond. Turbo-Generator 3/60, 2400 V, 3600 RPM, 200 PSI
5500 KW, G.E. N.C. Turbo-Generator 3/50, 2300 V, 3000 RPM 600 PSIG 650°TT, 150# B.P.
1500 KW, G.E. Cond. Extr. Turbo-Gen. 3/60, 2400 V, 3600 RPM 200/400 PSIG, 750°TT, 15# Extr.
1000 KW, Worth-Moore, Cond. Ext. Turbine, 3/60, 245/490V, 3600 RPM, 130-300# I.P., 10# Ext.
300 KW. G.M., 8-268A, Diesel Units (2) 3 ph, 60 cycle, 480 V, 1200 RPM.
1500 KW, West. Motor Generator Sets (2) 3/60, 2300/4600 Volts A.C.—250 volts D.C., 514 RPM

**BREW, WOLTMAN & COMPANY, INC.**
50 CHURCH ST., N.Y. 7, N.Y.

Circle 521 on Reader Service Card

**TRANSFORMERS—60 CYCLE**

| Qu | KVA | Make | Type | Phase | Voltages |
|---|---|---|---|---|---|
| 2 | 3000 | Maloney | TCR | 3 | 7200/6600-4160/3480 |
| 2 | 750 | G.E. | K | 1 | 4600-120/240 |
| 1 | 500 | Penna. | (Askarel) | 3 | 13470Y/7200-240 |
| 2 | 250 | G.E. | H Pyranol | 1 | 4800/2830Y/120/240 |
| 3 | 200 | G.E. | H8F2F | 1 | 2400/4160-240/480 |
| 3 | 200 | Amer. | CC | 1 | 4160/7200-240/480 |
| 3 | 75 | G.E. | KF | 1 | 2400/4160-120/240 |
| 3 | 50 | G.E. | H | 1 | 2400/4160-240/120 |
| 1 | 50 | Amer. | Absotol | 3 | 4160-120/208Y |
| 4 | 25 | West. | Hyperail | 1 | 2400/4160-120/240 |
| 6 | 25 | G.E. | Dry | 1 | 2200-440 |

**MOTOR GENERATOR SETS**

| Qu | KW | Make | Speed | DC | AC |
|---|---|---|---|---|---|
| 1 | 75 | EM | 1200 | 250 | 3ph. 220V. |
| 1 | 75 | G.E. | 1200 | 125 | 2300/4160 3ph. |
| 1 | 175 | West. | 1200 | 125 | 4150 3ph. |
| 1 | 300 | G.E. | 1200 | 250 | 2300/4160Y SR |
| 1 | 300 | Al.-Ch. | 1200 | 125/250 | 3ph. 440V. |
| 1 | 1000 | West. | 720 | 600 | 2300/4160Y |
| 1 | 45 | Cont. | 1200 | 30 | 75 HP-440V 8q Cg |

**ENGINE GENERATOR SETS**

1—Hermies Gas HXE 62.5 KVA Weighs 2/60/450 —1200

1—Wisconsin Gas (Air) PE-9g 7.5 KVA Master 1 or 3/120—2200 r.p.m.

**SLIP RING MOTORS**

| Qu | HP | Make | Speed | Type | Volts |
|---|---|---|---|---|---|
| 3 | 40 | West. | 600 | CW | 220/440 |
| 1 | 60 | G.E. | 1200 | MT | 220 |
| 1 | 60 | G.E. | 850 | MT548 | 440 |
| 1 | 75 | G.E. | 600 | IM | 440 |
| 1 | 150 | West. | 1200 | T.E.F.C. B.B. | 220 |
| 2 | 150 | Allis-Ch. | 1200 | AT-RW | 2300 |
| 1 | 250 | West. | 600 | CW | 440 |
| 1 | 250 | West. | 1200 | CW | 2300 |
| 1 | 450 | West. | 1200 | CW-4-30-9 | 220 |
| 1 | 500 | G.E. | 450 | MT | 2300 |
| 1 | 500 | G.E. | 1200 | M302Z 2300/4160Y | |
| 1 | 50 | G.E. | 570 | MT352 | 220/440 |

**D. C. MOTORS—230 VOLTS**

| Qu | HP | Make | Speed | Type |
|---|---|---|---|---|
| 1 | 350 | G.E. | 1200 | Pedestal |
| 1 | 50 | G.E. | 1750 | 175 FR |
| 1 | 30 | West. | 600/1400 | SK-4031543 |

**SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.**

1—300 HP, 1200, Allis Chalmers, 2300/4160Y
1—275 HP, 1120 RPM G.E. Type KT 6501R6 2300V
2—200 HP, 1790 RPM, G.E. Elec. KF, TEFC, 2300V
3—150 HP, 1800 G.E. TEFC Exp. 230/460
1—100 HP, 1775 RPM G.E. KTF-543 3 ph 60-440V.
1— 75 HP, 3600 RPM Cont. NP 505—440V Exp. P
1— 50 HP, 3600 Cont. Sz. Fr. 220/440
2—100 HP, 3600 RPM Cont. NP 585-S 440V Exp. Proof

**MOTORS—SYNCHRONOUS—3 ph. 60 cy.**

100 HP 900 RPM G.E. Form BL 2300V.
425 HP 600 RPM G.E. Type TS 2300 V.
125 HP 900 RPM G.E. Type TS 440/550 V.
150 HP 3600 RPM G.E. type TS Fr. 956Y 2300 V.
150 HP 1800 RPM G.E. Type TS 230 V.
300 HP 720 RPM Elec. Machinery t.e.f.c. 2300 V.
325 HP 900 RPM West—2300 V.
400 HP 450 RPM Westinghouse Type HR 440 V
75 HP 1500 RPM Crocker-Wheeler Type ALY 220/440V B.B.


FOR POWER
J.L. HEMPHILL & CO.


Circle 528 on Reader Service Card


**TRANSFORMERS**

1—16667 kva G.E. 3/60/69000/11500
1— 6667 kva Westinghouse 3/60/115,000Y/13750
1— 6000 kva G.E. 3/60000/2400/4160Y
1—5000/6250 kva. GE 3/60/115,000 pri. 11,500 sec. (new)
1— 2000 kva Nia. Askarel. 3/13800/4160Y/2400
3— 1500 kva Wagner, 1/60 cy. 6900—2400/4160Y
3— 1000 kva Standard, 1/44000/6600
3— 1000 kva Standard. 1/69000/4160Y/2400
3— 1000 kva Standard. 1/34400/480
3— 833 Allis Chalmers 1/60/12,000-480
3— 750 kva. GE 1/60/13,800 pri. 480 sec.
3— 500 kva. GE 1/60/11,500 pri. 480 sec.
3— 333 kva. GE Spirakore 1/60/2400/4160Y, 600 sec.
3— 333 Kva. GE Spirakore 1/60/2400/4160Y pri. 120/208Y sec.
3— 150 kva. Uptegraff 1/60/4800 pri. 480 sec.
3— 150 kva. dry Standard, 1/60/2400/4160Y pri. 240/480 sec.
3— 100 kva. Uptegraff 1/60/2400/4160Y pri. 240/480 sec.
3— 100 kva. GE H.K. 1/60/4800/8320Y pri. 480 sec.
3— 100 kva G.E., 2400/4160Y—120x240
3— 75 kva G.E., 2400/4160Y—120x240
3— 50 kva WEST CRP, 4160/7200Y, 120/240

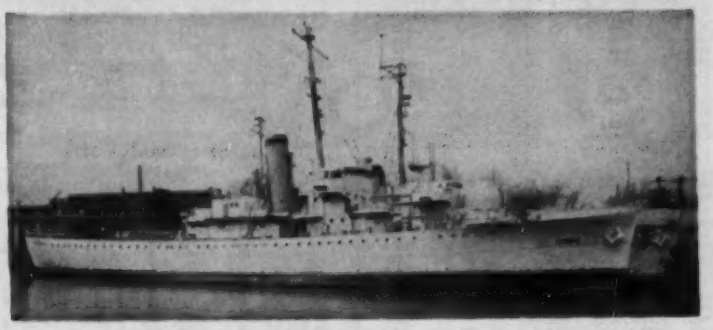
**ERIE ELECTRIC CO., INC.**
28 Mechanic St. Buffalo 2, N. Y.


Circle 529 on Reader Service Card


AUTOMATIC and MANUAL
Gas or DIESEL GENERATOR UNITS
Complete Switchboard Design and Construction
USED & REBUILT EQUIPMENT
UNIVERSAL POWER ENGINEERING CO.
382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300


Circle 530 on Reader Service Card


**FOR SALE: Turbo-Electric Vessel "TAMPA"**



**Use as floating 2600 K.V.A. Power Plant**

Power plant mfg by Westinghouse. Turbine: 3220 HP @ 3600 RPM—250 PSI—175° superheat — 28½" vacuum — 1½" back pressure. Water rate: 11.2 lbs/KW hr. Generator: 2600 K.V.A.—2300 volts—3 phase—60 cycle—.8 PF—655 amps—3600 RPM—serial no. 4954746. Boilers: 2 B & W watertube—shop no. MB-1137—cross-drum sinuous header type. Total heating surface 8514 including superheater—WP 250 lbs—175° superheat. Oil burning; furnace volume 437 cu. ft. Units complete with all auxiliaries such as fuel oil service pumps; oil heaters, switchgear, condensers, circulating pumps, etc. Has complete machine shop aboard, and quarters for personnel. All equipment in place. Maximum draft 16'1"—but vessel can be towed in light condition for use on shallow rivers. AVAILABLE IMMEDIATELY.

**The Boston Metals Company**
313 E. Baltimore St. — LExington 9-1900 — Baltimore 2, Md.


Circle 523 on Reader Service Card


**TRANSFORMERS**

BOUGHT · SOLD · RENTED
REWOUND · RE-DESIGNED
MANUFACTURED
*Ask for our Stock List*

**For Sale**
3—2500 KVA G-E 69000—2300Y
3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800
3—1500 KVA G-E 69000—2300Y
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio
*"America's Exclusive Independent Transformer Service Shop"*


Circle 524 on Reader Service Card


**FOR SALE**

1500 KW, 80% Power Factor, 3 phase, 60 cycle, 2300 volts, 3600 RPM, General Electric 5-stage noncondensing steam turbine generator unit, 375 PSIG, 700° FTT, 125# exhaust back pressure, complete with direct connected shaft exciter and switchgear. Excellent condition—available immediate delivery.

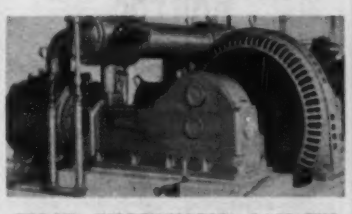
**EUCLID ENGINEERING CORPORATION**
909 National City East Sixth Building
Cleveland 14, Ohio


Circle 526 on Reader Service Card


MOTORS · GENERATORS
TRANSFORMERS
NEW · REBUILT
ELECTRIC EQUIPMENT CO.
WORLD'S LARGEST INVENTORY
CALL COLLECT OR WRITE
P.O. BOX 11 · ROCHESTER 1, N.Y.


Circle 527 on Reader Service Card


LARGE CAPACITY
**AIR COMPRESSOR**



700 HP—WORTHINGTON—3468 CFM
125 PSI — LATE STYLE
*Inspect on Original Foundation*
**EARL E. KNOX CO.**
1109 BACON ST. ERIE PA.
GL 6-7037


Circle 525 on Reader Service Card

## 37 Years Dependable Service

**SLIP RING MOTORS 3 Ph., 60 Cy.**

| H.P. | Volts | Make | Speed |
|---|---|---|---|
| 500 | 4000/2300 | G.E. | 600 |
| 450 | 4000/2300 | G.E. | 1200 |
| 400 | 4000/2300 | Whse. | 720 |
| 300 | 4000/2300 | G.E. | 720 |
| 300 | 2300 | G.E. | 600 |
| 300 | 440 | G.E. (hoist) | 600 |
| 300 | 440 | Whse. | 3600 |
| 225 | 4000/2300 | G.E. (hoist) | 600 |
| 200 | 2300 | G.E. | 600 |
| 200 | 2300/440 | G.E. | 720 |
| 150 | 230/440 | Whse. | 720 |
| 125 | 2300 | G.E. | 900 |

**AC GENERATORS or SYN MOTORS, 60 Cy.**

| H.P. | Volts | Make | Type | R.P.M. |
|---|---|---|---|---|
| 400 | 2300 | G.E. | TS | 1800 |
| 400 | 2300/440 | G.E. | ATI | 720 |
| 300 | 440/220 | G.E. | TS | 450 |
| 300 | 2300/440 | G.E. | TS | 1200 |
| 200 | 440 | G.E. | TS | 600 |
| 150 | 440/220 | Whse. | G | 1200 |
| 125 | 440/220 | Whse. | HR | 600 |

**SQUIRREL CAGE MOTORS**

| | | | | |
|---|---|---|---|---|
| 500 | 2300/4000 | Elliott | SC | 1800 |
| 400 | 2300 | G.E. | FT | 3600 |
| 400 | 2300/4000 | G.E. | K | 1200 |
| 350 | 2300/4000 | G.E. | SEDP | 3600 |
| 350 | 2300/4000 | G.E. | K | 600 |
| 300(2) | 2300 | G.E. | FT | 3600 |
| 300 | 2300/4000 | L. Allis. | FS | 1200 |
| 300 | 2300/440 | G.E. | SEDP | 1200 |
| 300 | 2300/4000 | Cont'l. | Spl.-Prf. | 720 |
| 300 | 2300/400 | G.E. | KT | 600 |
| 250 | 2300/4000 | G.E. | K | 720 |
| 200 | 2300 | G.E. | KT | 1200 |
| 200 | 2200 | Cont. | TEFC | 3600 |
| 180 | 440 | Whse. | X-pf. | 3600 |
| 150 | 440/220 | Cont'l. | X-pf. | 1800 |
| 150 | 440/220 | G.E. | TEFC | 720 |
| 150 | 2200/440 | | KT | 600 |
| 150 | 2300/440 | G.E. | TEFC | 3600 |
| 125 | 2300/440 | G.E. | FT | 1200 |
| 100(2) | 4400/2300 | L. Allis. | K | 600 |
| 100 | 2300 | Cont'l. | OX | 1200 |
| 60(2) | 440 | Cont'l. | X-pf. | 1800 |

**CIRCUIT BREAKERS, 3 Pole**

4—1600 Amp., DA-50, Whse., 600 V., Air
1—600 Amp., Al. Chal., 15 KV, Outdoor
6— 600 Amp., R. Smith, 7.5 KV, Sol. oper.
1— 400 Amp., R. Smith, 7.5 KV, outdoor, New

**D. C. MOTORS**

| H.P. | Volts | Make | Type | Speed |
|---|---|---|---|---|
| 150 | 230 | El. Dyn. | B/brg. | 900 |
| 60/75 | 230 | G.E. (new) | CD | 500/1500 |
| 90 | 230 | G.E. | CD | 1750 |
| 50 | 230 | G.E.(4) | CD | 1150 |

**MOTOR GENERATOR SETS**

| KW | Make | Input.. AC | Motor Type | Output V., DC |
|---|---|---|---|---|
| 300 | Whse. | 4150/460 | Syn. | 250/125 |
| 150 | G.E. | 440/220 | Syn. | 250 |
| 125 | G.E. | 440/220 | Sq. Ca. | 125 |
| 100 | G.E. | 2300/440 | Syn. | 250 |
| 75 | Cr. Wh. | 440/220 | Sq. Ca. | 240/120 |
| 70 | El. Dyn. | 440 | Sq. Ca. | 70 |
| 65 | G. E. B | 2200/440 | Sq. Ca. | 230 |

**TRANSFORMERS 60 Cy.**

1—500 kva, Al Ch., 2400/4160Y—600 volts, 3 ph.
2—300 kva, G.E., 13800—240/480 V.
3—200 kva, Mol., 12,800—2300 V.
3—333 kva, G.E., 12,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—200 kva, G.E., 12,800—480 V.
3—200 kva, G.E. 4156—480/240 V.
3—167 kva, Whse., 4156—480 V.
3—150 kva, Al. Ch., 2400—230 V.
3—150 kva, G.E., 12,200—2300 V.
3—100 kva, Whse., 4800/2400-240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pwr.

**GASOLINE—ENGINE GENERATOR SETS**

3—37½ kva, 1800 R. 220 V 3/60, Cont'l., 6 cyl.

*only partial listing*

**STEPHEN HALL & CO.**
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.


Circle 531 on Reader Service Card


## HERCULES DIESEL ENGINE GENERATOR SETS

NEW — 1959 — Portable — Skid Mounted — 6 Cylinder 1800 RPM 0.8 P.F.

30 — K.W. — 120/208-Volts — 3 phase — 60 cycle. 4-Wire with Neutral for single phase. Enclosed—Designed for outdoor use. Heated for fast winter starting. Complete with Switchboard & Engine Panel. Automatic Voltage Regulation. Inspection under power invited. Immediate Shipment from Phila. or Miami, Fla.

*Sale or Rent*

**T. B. MacCABE CO.**
4314 Clarissa St. — Philadelphia 40, Pa.
Phone — DAvenport 4-8300


Circle 532 on Reader Service Card


## NEW BOILERS FROM S.S. HAWAII

*NEVER USED*

## 8 B&W WATER TUBE BOILERS

*With Separately Fired Superheaters*

634 pounds working pressure—850° T.T.—6053 square feet generating surface. Capacity 158,000 pounds steam per hour. Capacity plus 20%—190,000 pounds steam per hour. Total dry weight 135,258 pounds. Units complete with burners, economizers, soot blowers, valves, controls, etc. These boilers can be converted to operate on natural gas and #2 oil. Complete with fully automatic feedwater & combustion controls. Units can be supplied with all necessary pumps, heaters, boiler mountings, etc.

**DIMENSIONS:**
Overall width 11'
Height over drum 21'
Depth 15'

**THE BOSTON METALS CO.**
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900


Circle 533 on Reader Service Card


## LOW-PRESSURE BOILERS

Three boilers, Combustion Engineering Co., Type VU, 2-drum, 11,371 sq. ft. surface, 110,000 lbs./hr. capacity—200 psi.

Complete with pulverizers, coal feeders, crushers, conveying equipment, ash removal equipment and auxiliaries.

Installed in 1943 and operated less than four years. Location: Louisville, Kentucky.

Complete details upon request to
**K. M. MILLER**

**ROHM & HAAS COMPANY**
222 West Washington Sq.
Philadelphia 5, Pa.


Circle 534 on Reader Service Card


## MODERN POWER BOILERS

2—Babcock & Wilcox Boilers of 265,000# steam per hour at 750 psi and 730 degrees F. New in 1949. Units are complete.

Other boilers available

*Dismantling and Re-erection under one responsibility*

**MIDWEST BOILER & TURBINE CO.**
Warner, New Hampshire


Circle 536 on Reader Service Card


## FOR SALE

675 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 500 KW. 3/60/2300V. COMPLETE.

1275 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 900 KW. 3/60/2300 V. NEW 1953.

3000 KW GE CURTIS CONDENSING TURBO. 400# ISP. 3/60/2300 VOLTS. BUILT 1930. COMPLETE. EXCELLENT.

**WHISLER EQUIPMENT CO.**
1908 Railway Exchange Building
St. Louis 1, Mo.


Circle 537 on Reader Service Card


## SEARCHLIGHT Equipment Locating SERVICE

*No Cost or Obligation*

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used power equipment not currently advertised. This service is for USER-BUYERS only. How to use: Check the dealer ads to see if what you want is currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

**SEARCHLIGHT EQUIPMENT LOCATING SERVICE**
c/o POWER Classified Advertising
P.O. Box 12, New York 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

---

**SEARCHLIGHT EQUIPMENT LOCATING SERVICE,**
c/o Power, P.O. Box 12, N.Y. 36, N.Y.

Please help us to locate the following used equipment:

.....

.....

NAME .....

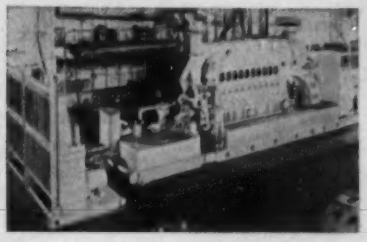
TITLE ..... COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

6/60

## Portable diesel engine generator for peaking power



A 1000 kw portable power plant will supplement existing steam plant of the city of Norwalk, Ohio. Remanufactured by A. G. Schoonmaker Co., the portable plant with Fairbanks-Morse model 38D819 ten cylinder diesel engine was considered by city engineers the most efficient and economical for peaking purposes. Remanufactured diesel generators from 100 kw to 1000 kw are available for purchase, on short term lease, long term lease or on a lease-option arrangement for installation anywhere in the world.

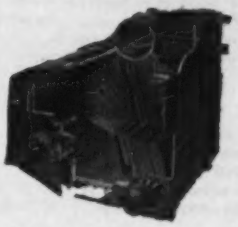
**G. SCHOONMAKER COMPANY, Inc.**

Foot of Spring St., Sausalito, Calif.
EDgewater 2-1490

50 Church Street, New York 7, N. Y.
Digby 9-4350

Circle 540 on Reader Service Card

## BOILERS NEW UNASSEMBLED



| # Steam/hr. | Key | PSI | Temp. |
|---|---|---|---|
| 122,500 | DF | 565 | 850 |
| 121,650 | DF | 565 | 850 |
| 60,000 | SF | 435 | 750 |
| 74,000 | H | 280 | 500 |
| 55,000 | A | 240 | — |

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

**Peinik-Loconti Industrial Supply, Inc.**

315 Oriskany St., Yorkville, N.Y.
Utica, N. Y. Ph. RE 6-4621, RE 2-4513

Circle 541 on Reader Service Card

## BOILERS

FOR SALE, SPECIALLY
BABCOCK & WILCOX
SECTIONAL HEADER

ARG CHEMICAL MACHINERY
807 Fifth Avenue, New York 17, N. Y.

Circle 522 on Reader Service Card

## MISS POWER EQUIPMENT SAYS,

*"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed NEW and REBUILT MOTORS"*

**SQUIRREL CAGE MOTORS NEW AND GUARANTEED REBUILT**

| HP | Make | Type | Speed |
|---|---|---|---|
| 500 | L.A. S.B. Splash 440 Volt | FX-1408 | 3600 |
| 500 | G.E. S.B. Open | IK | 1200 |
| 400 | West. S.B. Drip | CSP-581 | 1800 |
| 400 | L.A. S.B. Splash | | 1800 |
| 400 | G.E. S.B. Open | IK | 1200 |
| 400 | G.E. S.B. Open | IK-178 | 900 |
| 400 | West. S.B. Open | CS | 900 |
| 350 | West S.B. Drip | CS-22550H | 1200 |
| 300 | G.E. S.B. Open | IK | 1800 |
| 300 | G.E. S.B. Open | IK | 900 |
| 300 | G.E. S.B. Open | IK | 720 |
| 300 | G.E. S.B. Open | KT-561 | 720 |
| 300 | West. S.B. Open | CS-1002 | 600 |
| 300 | G.E. S.B. Open | IK | 600 |
| 250 | El. Dyn. TEFCBB | KNX | 1800 |
| 250 | G.E. S.B. Open | KT | 1800 |
| 250 | West. S.B. Splash | CS-875 | 1800 |
| 250 | G.E. S.B. Open 2300 Volt | IK-10 | 1200 |
| 250 | G.E. S.B. Open | IK | 1200 |
| 250 | G.E. S.B. Open | IK | 900 |
| 250 | G.E. S.B. Open | IK | 720 |
| 200 | G.E. S.B. Drip | K-6225 | 1800 |
| 200 | West. S.S.B. Open | CS-855 | 1800 |
| 200 | West. S.B. Open | CS | 1200 |

**CASH FOR YOUR SURPLUS**

SEND YOUR LIST TODAY! NEW & USED Electrical Equipment

| | | | |
|---|---|---|---|
| 200 | G.E. S.B. Open | IK-15 | 1200 |
| 200 | G.E. S.B. Open | IK-156 | 1200 |
| 200 | G.E. S.B. Open 2200 v. | IK | 1200 |
| 200 | G.E. S.B. Open | IK | 900 |
| 200 | G.E. S.B. Open | K-6393 | 900 |
| 150 | Wagner TEFCBB | B88 | 1800 |
| 150 | G.E. S.B. Drip | K-6324 | 1800 |
| 150 | West. S.S.B. Open | CS-771-C | 1800 |
| 150 | Al. Chal. S.B. Open | AR | 1800 |
| 150 | West. S.B. Open 2200V | CS | 1800 |
| 150 | West. S.B. Drip | CS-772 | 1200 |
| 150 | G.E. S.B. Open | KT | 1200 |
| 150 | Al. Chal. TEFCBB | AZ | 900 |
| 150 | F.M. S.B. Open | H-24A | 900 |
| 150 | G.E. S.B. Open | IK | 900 |
| 150 | L.A. S.B. Splash | FX-1368 | 900 |
| 150 | G.E. S.B. Open | IK | 720 |
| 150 | West. S.S.B. Open | CS-876-C | 600 |
| 125 | G.E. TEFCBB | K | 3600 |
| 125 | Burke S.B. Open 440 Volt | N-388 | 3600 |
| 125 | Reliance T.E.F.C. S.B. | AA-5004 | 1800 |
| 125 | G.E. S.B. Open | IK | 1800 |
| 125 | West. S.S.B. Open | CS | 1800 |
| 125 | Al. Chal. S.B. Open | AR | 1800 |
| 125 | G.E. S.B. Open | KT-558 | 1200 |
| 125 | G.E. S.B. Open | IK | 1200 |

| | | | |
|---|---|---|---|
| 125 | F.M. S.B. Open | H | 900 |
| 125 | G.E. S.B. Open | IK | 720 |
| 125 | G.E. S.B. Open | IK | 600 |
| 100 | Al Chal. T.E.F.C. S.B. | ARZ-823 | 3600 |
| 100 | G.W. S.B. Open 2300 Volt | SC-445 | 3600 |
| 100 | G.E. S.B. Open | KT-548 | 1800 |
| 100 | G.E. S.B. Open | K-504 | 1800 |
| 100 | Reliance S.B. Open | AA-5004 | 1200 |
| 100 | West. TEFCBB | CS-779 | 1200 |
| 100 | G.E. S.B. Open | KT-547 | 1200 |
| 100 | West. SSB Open | CS-807 | 1200 |
| 100 | Al. Chal. T.E.F.C. S.B. XP | 28E8 | 900 |
| 100 | F.M. S.B. Open | H20C | 900 |
| 100 | F.M. S.B. Open | H | 720 |
| 100 | F.M. S.B. Open | H | 600 |
| 75 | West. S.B. Open New | CS-444 | 3600 |
| 75 | Master S.B. Splash | PA-585 | 1200 |
| 75 | Reliance S.B. Splash | 585 | 1200 |
| 75 | F.M. S.B. Open | H | 900 |
| 75 | F.M. S.B. Open | H | 600 |
| 60 | West. TEFCBB | CS-445 | 3600 |
| 60 | G.E. TEFCBB | KF-445 | 3600 |
| 60 | L.A. TEFCBB-XP | EX-445 | 3600 |
| 60 | L.A. TEFCBB | JX-445 | 3600 |
| 60 | West. TEFCBB | CS-445 | 1800 |
| 60 | Cent. TEFCBB | NP-504 | 1800 |

FREE CATALOG. This is a partial listing. We are continually changing our stock, and can fill your requirements at any time. Send for our free catalog. In Stock, fractional horsepower up to 500.

Motors, Control Equipment, AC and DC Generators, MG sets and transformers.
PHONE or WIRE us COLLECT
LARGE LINE of SLIP RING MOTORS & CONTROLS.

**POWER EQUIPMENT CO.**

8 CAIRN STREET • PHONE BEverly 5-1662 • P O BOX 534 • ROCHESTER 2 N Y

Circle 538 on Reader Service Card

## CHECK WITH WAGNER FIRST!

**Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P.**
**OUR 54th YEAR**

**A. C. MOTORS—60 CYCLE**

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 800 | Whse. (2) | Sq. Cage | 2300 | 1800 |
| 750 | G.E. | Slipring | 2300 | 514 |
| 600 | G.E. | Synch. | 480 | 900 |
| 600 | Elliott (2) | Sq. Cage | 2300 | 900 |
| 500 | Al. Ch. 3 brg. | Slipring | 440 | 514 |
| 500 | Allis Ch. | Slipring | 2300/440 | 600 |
| 400 | G.E. | Sq. Cage | 440 | 1200 |
| 400 | Whse. | Sq. Cage | 2300 | 514 |
| 400 | Marathon (2) | Sq. Cage | 2300 | 3600 |
| 400 | G.E. | Slipring | 2300 | 514 |
| 400 | El. Machy. | Synch. | 2300/4000 | 600 |
| 350 | Gr. Borori b.b. | Sq. Cage | 4000/440 | 720 |
| 350 | G.E. | Sq. Cage | 2300 | 1800 |
| 350 | Allis Ch. | Slipring | 2300/4000 | 600 |
| 300 | Whse. | Synch. | 440 | 1200 |
| 300 | G.E. | Slipring | 230/440 | 514 |
| 250 | G.E. | Sq. Cage | 2300/440 | 1200 |
| 250 | G.E. | Sq. Cage | 2300/440 | 450 |
| 250 | Gen. Elec. | Sq. Cage | 440 | 3600 |
| 250 | G.E. TEFC | Sq. Cage | 440 | 1200 |
| 250 | Whse. | Sq. Cage | 2300/440 | 600 |
| 250 | Whse. (4) | Slipring | 2300/440 | 600 |
| 200 | Gen. Elec. | Synch. | 550/440 | 400 |
| 200 | G.E. b.b. | Sq. Cage | 220/440 | 720 |
| 200 | G.E. | Slipring | 220/440 | 450 |
| 200 | G.E. | Slipring | 440 | 600 |
| 200 | G.E. | Slipring | 2300 | 900 |
| 200 | Reliance b.b. | Sq. Cage | 220/440 | 1800 |
| 200 | Allis Ch. | Slipring | 2300/440 | 720 |
| 150 | Whse. ZP | Sq. Cage | 440 | 3600 |
| 150 | G.E. (4) | Slipring | 2300/440 | 600 |
| 150 | G.E. (2) | Sq. Cage | 2300/440 | 1800 |
| 150 | Whse. | Slipring | 2300/440 | 1200 |
| 150 | Whse. | Slipring | 2300 | 450 |
| 150 | G.E. | Sq. Cage | 2300 | 900 |
| 125 | A.C. TEFC | Sq. Cage | 220/440 | 1800 |
| 125 | El. Machy. (2) | Synch. | 220/440 | 400 |
| 125 | G.E. TEFC | Sq. Cage | 2300 | 3600 |
| 125 | Al. Ch. TEFC | Sq. Cage | 220/440 | 600 |
| 125 | G.E. (2) | Slipring | 220/440 | 514 |
| 125 | Mar. TEFC | Sq. Cage | 220/440 | 1200 |
| 100 | Al. Ch. TEFC | Sq. Cage | 2300 | 1800 |
| 75 | G.E. b.b. (8) | Sq. Cage | 220/440 | 1200 |

**D. C. GENERATORS**

| KW | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 300 | Gen. Elec. | CY-221 | 230/330 | 1200 |
| 300 | Gen. Elec. | RC | 250 | 1450 |
| 100 | Delco b.b. | Into | 120/240 | 1200 |
| 75 | Allis Ch. b.b. | EB-1161 | 125 | 1500 |
| 75 | G.E. b.b. | CD | 250 | 1750 |
| 60 | Ideal | D | 125 | 1150 |
| 60 | G.E. b.b. | CD | 600 | 1750 |
| 50 | G.E. (2) | CD-1129 | 250 | 1200 |

**D. C. MOTORS**

| HP | Mfr. | Type | Volts | Speed |
|---|---|---|---|---|
| 250 | Cr. Wh. | 161-H | 230 | 1150 |
| 200 | G.E. (2) | RC-88 | 230 | 1150 |
| 200 | Whse. b.b. | SK | 230 | 287/575 |
| 150 | Rel. TEFC b.b. | 2350-F | 230 | 850 |
| 150 | Whse. | SK-210 | 230 | 250/1000 |
| 125 | G.E. | CD-173 | 230 | 575/1150 |
| 100 | Elliott b.b. T.E. | JH-FE | 230 | 1150 |
| 100 | El. Dyn. b.b. (2) | 30-S | 230 | 450/1200 |
| 75/100 | Whse. | SK-191 | 230 | 300/900 |
| 75 | G.E. b.b. | CD-115 | 230 | 1150 |
| 60 | G.E. TEFC b.b. | CD-125 | 230 | 1150 |
| 50 | G.E. | BP-10 | 230 | 250/1000 |
| 50 | Century new | DN-514 | 230 | 1150/1750 |
| 40/50 | Reliance b.b. | 310-T | 230 | 600/1800 |
| 40 | F. Morse b.b. | D-405 | 230 | 1750 |

**MOTOR-GENERATOR SETS**

| KW | Mfr. | Input V | Output V |
|---|---|---|---|
| 600 | Allis Ch. | 440 AC | 250 DC |
| 300 | Whse. (2) | 2300/440 AC | 250 DC |
| 200 | Whse. synch. | 2201440 AC | 55 DC |
| 200 | Gen. Elec.* | 230/440 AC | 125 DC |
| 135 | Gen. Elec.* | 2300/4000 AC | 250 DC |
| 135 | Whse. | 230/440 AC | 250 DC |
| 100 | Delco b.b. | 220/440 AC | 120/240 DC |
| 80 | Star b.b. Synch. | 220/440 AC | 250 DC |
| 75 | Whse. Synch. | 220/440 AC | 250 DC |
| 60 | Ideal | 220/440 AC | 125 DC |
| 50 | G.E. b.b. (2) | 220/440 AC | 250 DC |
| 35 | Reliance b.b. | 220/440 AC | 250 DC |

**Arthur Wagner Co.** Certified

MOnroe 6-7409
1435 W RANDOLPH ST
CHICAGO 7, ILLINOIS

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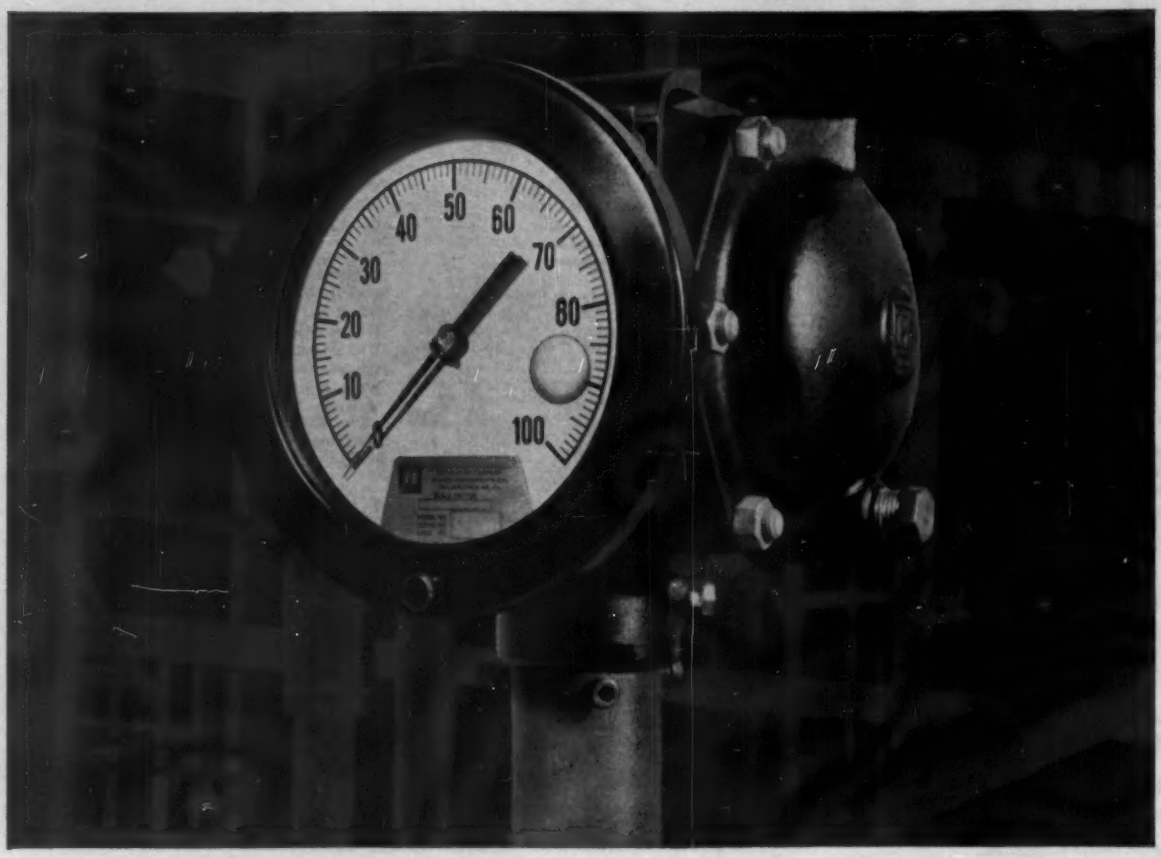



# New indicating bellows meter is accurate, rugged and safe in any atmosphere

Use this new bellows meter for any flow or liquid level application where you want local indication, but don't need recording or transmission. It combines the advantages of the mercuryless bellows meter body with the convenience of an easy-to-read 6-inch dial indicator.

Make pressure connections from either the top or bottom of the meter body, depending on whether you want the meter to be self-venting, draining or purging. And forget corrosion worries; all parts of the bellows exposed to process fluids are of seamless stainless steel construction.

This rugged meter will perform accurately in the toughest service. Two meter bodies are available with pressure ratings of 1000 and 2500 psi, tested at 1500 and 4000 psi respectively. And you can use the meter in hazardous atmospheres because it is self-powered . . . at any ambient temperature between −40° and +250°F. In the indicating movement, a stainless steel pointer pinion and a nylon-faced gear sector assure long life and sustained calibration accuracy of ±1% full scale (ranges of 0-50 inches of water and above) and ±1¼% full scale (ranges below 0-50 inches of water).

This new bellows meter has many other features . . . ease of calibration, simple range change, automatic ambient temperature and static pressure compensation, to name a few. Your nearby Honeywell field engineer can give you complete details. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

75th YEAR
PIONEERING THE FUTURE

**Honeywell**

First in Control

SINCE 1885

Monel alloy feedwater heater tube (shown emerging at lower right) is being ultrasonically scanned. If imperfection shows up, signal stops drive and operator shunts tube into discard rack.

# How the Immerscope test assures trouble-free Monel tubes for high pressure feedwater heaters

**With an ultrasonic ear** sharply tuned, the Immerscope you see above inspects every inch of every length of Monel® nickel-copper alloy feedwater heater tubing produced at Huntington Alloy Products mill.

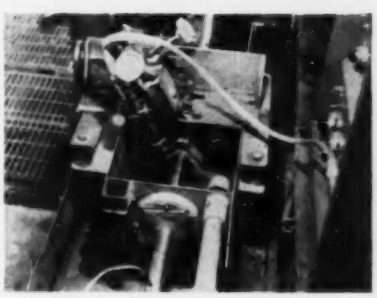
And this is only one of a number of places where forgings, extruded tube shells, and the tubes in various dimensions are carefully checked.

**In the Immerscope test,** a probe beams ultrasonic waves into the rotating tube as it is driven slowly through water. Any deviation from standard is translated into a pip on an oscilloscope. Just one pip and the drive cuts out. A horn blows alerting the operator to remove the tube.

**Precision-made and precision-tested, Monel alloy tubes meet today's needs** – they have the strength it takes to handle high pressures and temperatures in modern steam plants. Monel alloy tubes are corrosion-resisting and have good heat transfer properties. They are workable and weldable—easily joined to tube sheets.

**Keep Monel alloy in mind,** whether it be in the designing stage or retubing. Huntington supplies tubes in lengths up to 85 feet, pre-bent if desired. Prompt delivery can be assured on urgent jobs. *Inco trademark

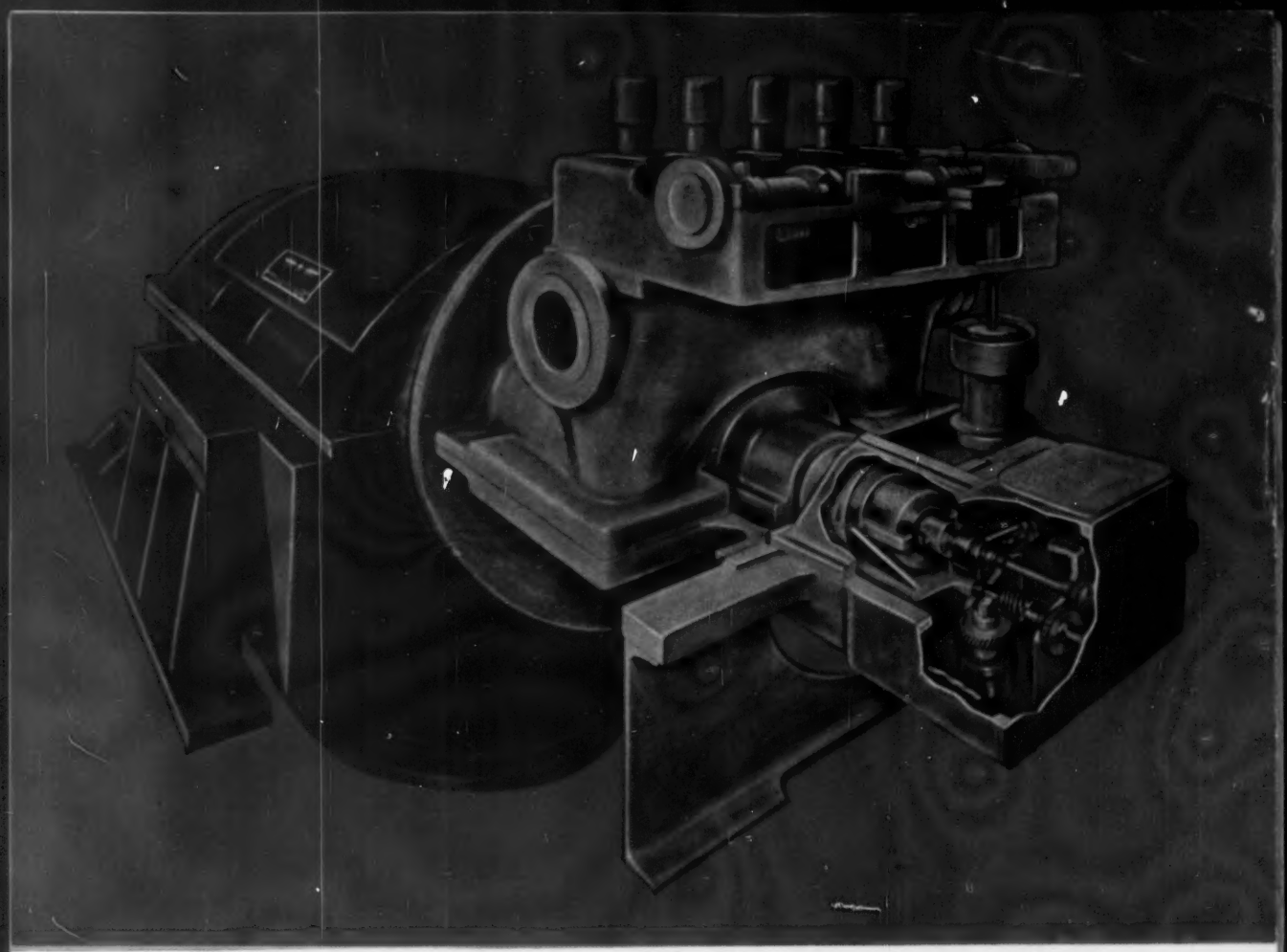
**HUNTINGTON ALLOY PRODUCTS DIVISION**
**The International Nickel Company, Inc.**
**Huntington 17, West Virginia**



Ultrasonic probe sends sound waves into the metal where waves bounce back and forth between inner and outer surface of tube (shown left) until 100% of tube has been inspected.

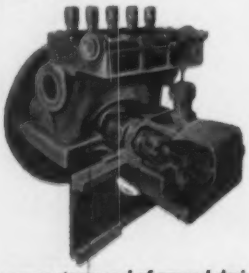
**MONEL.®**

**For more facts circle 202 on Reader Service card, p 103**

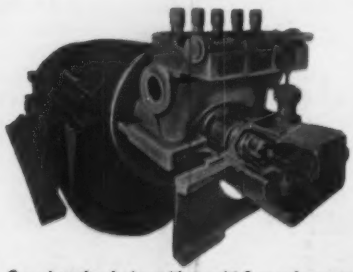


**HOW WE ASSURE RELIABILITY IN A NEW DESIGN**

1. Use an existing high-speed bearing case and a high capacity thrust bearing.



2. Add a high-pressure steam end of proved design with cam operated automatic nozzle control valves.



3. Complete the design with a multi-flow exhaust end.

# HOW TO BUILD THE WORLD'S FASTEST 10,000 HP TURBINE

You can order this trail-blazing 15,000 rpm centrifugal compressor-drive turbine today with complete confidence because it makes use of components of proved reliability

Progress without sacrificing reliability is the goal of Worthington's Steam Turbine Division. How Worthington's creative engineering and advanced planning works to your advantage is illustrated by the steps taken in the continuing development of turbines of increasingly higher speeds:

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2. Modify designs already in use in other high speed applications.
3. Thoroughly test these modifications to prove their reliability before field application.

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